Natural Science

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NOTES AND COMMENTS.

Pure Science.

THE debt of the world to pure science was the subject of Prof. J. J. Stevenson's (retiring President's) address to the New York Academy of Sciences on February 28, 1898, and the lecture is now available in the last volume of the *Annals* (xi. (1898) pp. 177-192). The thesis is an interesting one—"That the foundation of industrial advance was laid by workers in pure science, for the most part ignorant of utility and caring little about it," and the evidence should give pause to those impatient utilitarian spirits who would weigh all scientific work on the balance of "practical results." From the history of astronomy and geology, physics and chemistry, botany and zoology, examples are taken which show that what might have seemed out-of-the-way investigations—prompted by the curious or contemplative spirit—have had the most unlooked-for and far-reaching results in practice. It is not, indeed, to be forgotten that the converse thesis is also true,—that practical lore has in hundreds of cases reacted upon theory. The investigator prepares for the inventor, but the inventor in turn stimulates the investigator. Yet is there not a danger lest even this eloquent address may suggest that "pure science" requires an apology—a heresy which Bacon long ago confuted in his distinction between experiments which are "lucifera" and those which are "fructifera"? Is there not reason to recall his words: "Just as the vision of light itself is something more excellent and beautiful than its manifold uses, so without doubt the contemplation of things as they are, without superstition or imposture, without error or confusion, is in itself a nobler thing than the whole harvest of inventions"?

A Contribution to the Biology of Cock-Fighting.

E. BORDAGE, who has previously made some interesting observations on various cases of regeneration, has recently turned his scientific eye upon cock-fighting. It is one of the pastimes of Réunion, where the pugnacity of the cocks is such that the premaxillae and the anterior parts of the mandibles are sometimes torn away in the fury of combat.

In two or three months they are regenerated, alike as regards bony and horny tissue. The regeneration of the mandibular portion proceeds more slowly than that of the upper parts. The author entitles his paper "Cas de régenération du bec des oiseaux expliqué par la loi de Lessona" (*C. R. Soc. Biol.*, July 1898), but as Lessona's law is hardly as familiar as Boyle's we may be allowed to state it. In 1868, the illustrious Italian naturalist formulated the conclusion that in animals the parts which are capable of regeneration are those which run most risk of mutilation. This conclusion has been restated by Darwin and by Weismann (whose name the author spells in the usual French fashion) in the thesis that regeneration is an adaptive phenomenon. Weismann found some difficulty in regard to a stork which repaired the terminal half of its mandibles. But Bordage points out that male storks fight furiously. After this who can deny that cock-fighting has its utility?

A Delicate Operation.

IN a short paper entitled "Embryons sans noyau maternel" (*C. R. Ac. Sci.* cxxvii. (1898), pp. 528-531) Professor Yves Delage describes a remarkable experiment. He divided the egg of a sea-urchin under the microscope into two parts, one containing the nucleus and the centrosome, the other simply cytoplasmic. Beside them he placed an intact ovum, and then let spermatozoa in. All the three objects showed equal "sexual attraction," all were fertilised, and all segmented, the intact ovum most rapidly, the nucleated fragment more slowly, the non-nucleated fragment more slowly still. In one case, the development proceeded for three days; the intact ovum had become a typical gastrula, the nucleated fragment a smaller gastrula, and the non-nucleated fragment also a gastrula, but with very much reduced cavities, "presque virtuelles." All the cells showed nuclei. The experimenter concludes that fertilisation and some measure of development may occur in a fragment of ovum without nucleus or ovocentre. It is probably by these indirect paths that we shall eventually discover the real nature of fertilisation. According to Delage, two things must be distinguished—(*a*) the stimulus given to the ovum by a specially energetic kinoplasm brought in by the spermatozoon, perhaps in its centrosome; and (*b*) the mingling of heritable characteristics, or amphimixis. It must, of course, be observed that while the fertilised cytoplasmic fragment in Delage's clever experiment segmented, it did not really develop.

Birds and their Surroundings.

THE British Museum (Natural History) has recently placed on exhibition a model by the American ornithologist, Mr. A. H. Thayer,

which shows in a striking manner the value of coloration harmonising with the surroundings. This model consists of a box lined with light gray felt, but open at the top and front. In the middle of the box are two rough figures of birds, each identical in size, and sitting upon a perch. One is covered with the same gray felt as lines the box, and the other is darker in shade above than the felt and lighter than the felt below. A spectator standing close to the box sees both birds clearly, but three or four feet away the darker bird is almost invisible, and at six or eight feet entirely disappears from sight. The reason for this is that the lighter under-colour of the darker bird counteracts the shadow thrown by the top light, and makes the bird appear an uniform colour at a little distance, while in the case of the bird of the same colour as the surroundings a shadow throws it into strong relief. This exhibit, which strikingly demonstrates colour values, will be found in the small gallery leading from the central hall to the British birds.

The Skin and Fins of Ichthyosaurus.

Dr. Eberhard Fraas, to whom we are indebted for our first information concerning the outward form of the body in the extinct marine reptile *Ichthyosaurus*, has just published a description of another specimen from the Upper Lias of Wurtemberg, now in the National Museum at Buda Pesth (*Földtani Közlöny*, 1898, vol. xxviii. pp. 169-173, pl. ii.). It is now absolutely certain that this dolphin-shaped reptile had a small triangular fin on its back, and that the vertebral column turned downwards into the lower lobe of the laterally-compressed forked tail. It seems probable, however, that the newt-like crest of skin supposed to extend along the back behind the dorsal fin, was a deceptive appearance in the first specimen described. Four examples of *Ichthyosaurus*, showing the outline of the body, are now known from the Upper Lias of Wurtemberg—the first in the Stuttgart Museum, the second in a private collection at Brussels, the third at Buda Pesth, and the fourth probably destined for the Museum of the University of Tübingen. There is also a well-preserved detached tail from the Bavarian Lithographic Stone in the Palaeontological Museum, Munich. Thus rapidly has our knowledge of the subject progressed since Dr. Fraas first communicated his original drawing of the Stuttgart specimen to *Natural Science* in September 1892 (vol. i. p. 515).

Books and the Customs.

In a note on the dates of publication of Temminck and Laugier's "Planches coloriées," that wonderful collection of illustrations of birds first issued by Buffon, which has just appeared in the *Ibis*, Mr. Davies Sherborn calls attention to a publisher's notice of much interest.

Quoy, who reviewed the parts as they appeared in the *Bulletin des Sciences Naturelles*, says in one of his notices that the authors had abstained from giving any text to the first twenty parts for fear of increasing the price of the book, and above all from their delicacy of writing after the illustrious Buffon. They were, however, compelled to do so because the foreign Customs rejected a collection of plates without text, considering them as the product of the arts of France rather than as a scientific work destined to be circulated all over Europe. This was in 1824. Times have changed since then, but we can recall an instance of stupidity on the part of British Customs officials even within the past decade, connected with a book on "Greek Vases."

A Thorny Subject.

MR. C. E. BEECHER has published an interesting study on the "Origin of Spines" (*Am. Journ. Sci.* 1898, vi. pp. 1-20, 125-136, 249-268, 329-359, 73 figs.). He points out that the suggestion of protective function, so freely made, is not always valid; but although the elimination value of spines and related structures may be slight, yet the spinose condition itself can, he says, be shown to be of much importance. "It represents a stage of evolution, a degree of differentiation in the organism, a ratio of its adaptability to the environment, a result of selective forces, and a measure of vital power."

Mr. Beecher emphasizes the fact that spines or equivalent structures are rarely present in young forms, but appear during the process of growth, and he seeks to distinguish two types of spine-development. One type, well exemplified in the Barberry, shows that spines may develop from the degeneration of organs, as in plants from leaves, in animals from appendages, *e.g.* the spurs of the python, and so on. In the other, the ornamental type, well seen in the shell of *Spondylus*, the spines do not arise from a check to growth, but from an excessive development of functional parts. Further, just as in ontogeny spines of both types develop late, so phylogeny proves that spinose or ornamented forms have behind them a long history of simple unadorned ancestors. This is well seen in *Spondylus* itself, which is descended from forms with simple smooth shells; in many Brachiopods, which became spinose just before extinction; in the history of the whole phylum of Echinoderma, whose members have become increasingly spinose in geological time. Phylogenetic studies of this kind show also that the "maximum of generic, family, and ordinal differentiation is found at an early period, while the greatest specific differentiation occurs at a later period." That is, variation first affects physiological and internal structures, while later the changes are mainly physical and peripheral. In other words, in any developing group "the more important physiological and structural variations are the first to be subjected to heredity and natural selection, which tend to fix or hold

them in check. Features of less functional importance, as peripheral characters, are the last to be controlled, and therefore present the greatest diversity, while in this diversity spinosity is the limit of progress." As to the causation of the two types of spines, Mr. Beecher refers to the "general laws of organic change,"—that is, the stimulus or restraint of the environment, and the energy or deficiency of growth force. Of these four causes two tend to produce spines like those of *Berberis*, two to produce the ornamental type as in *Spondylus*. As no one of these causes is simple, and the action of each may be assisted by secondary causes such as sexual selection, mimetic influences, and so on, there are in all eleven causes of spine production, all of which are discussed in detail with illustrative examples.

The conclusions reached are, as indicated above, that on the one hand spinosity represents the limit of morphological variation, and on the other the decline or paracme of vitality. That is to say, alike in ontogeny and in phylogeny spines increase until maturity, and there is then in old age an "extravagant differentiation followed by a decline of spinous growth, and ending in extreme senility with their total absence." In other words, the great development of spinose organisms in a group represents the beginning of the decadence of the group.

Philosophy of Evolution.

WE cannot but welcome a paper of this type, more especially when, as in Mr. Beecher's case, the evidence brought forward is largely palaeontological. No one who has toiled through pages of controversy as to the probable action of natural selection in hypothetical cases, can fail to appreciate a genuine attempt to discover what natural selection has actually done in the past. But while recognising to the full the value and excellence of Mr. Beecher's work, it is difficult to avoid criticism of the frequent want of precision and clearness in his use of words, especially in the treatment of the philosophical aspects of the subject. The habit must, we think, lead sooner or later to much confusion of thought. For example, is any good end attained by the introduction of sentences like the following into a discussion of the question as to whether variation is limited or unlimited: "As far as can be seen, the limitations of the forms of species of animals and of plants end only with the aggregate number of possibilities within the functional scope of the organism. Beyond in either direction is death, and a passage from the organic to the inorganic"? The difficulty of comprehending this statement is in no way diminished by finding that the author seems to mean that variation is definite and orderly. Again, the author states that certain types of spines have been produced by the "law of repetition," which is "similar to induction in electrical physics, or to the force or stimulus of example in human conduct." Is not this merely biological mysticism? We also hear much of the "forces of sexual

selection, environment, and growth," as if all acted after a precisely similar fashion. Horns, we are told, may arise as the direct result of the action of the environment, but if they are confined to one sex it is "evidently a case of sexual selection." We do not suppose that Mr. Beecher regards this "force" as a kind of "Red Queen," whose fiat "Off with his head," or her horns, can be relied upon to assist the other "forces and laws" when they get into difficulties, but it is surely unfortunate that his language should lend itself so readily to such misapprehension.

Eyes in Bivalve Mollusca.

THE Acephala, or headless Mollusca, as the Pelecypoda have been termed, whilst possessing eyes in the normal position near the mouth when in the larval condition, have hitherto been supposed to be quite devoid of such organs when adult. Some of them, it is true, have developed organs of vision elsewhere, for instance, in the mantle-margins (*Pecten*, etc.), or at the extremities of the siphons (*Cardium*), but these have no connection with true cephalic eyes.

Dr. Paul Pelseneer has, however, recently discovered the existence of true cephalic eyes in certain groups (*C. R. Ac. Sci.* cxxvii. (1898), pp. 735 and 736). Since his account is short we give a full translation:—

> There exists in adult Lamellibranchs a pair of distinct and well-formed cephalic eyes. They consist of pits with pigmented walls filled by a cuticular lens, and they are thus intermediate in their structure between those of *Trochus* and *Patella*.
>
> These organs appear to be peculiar to most of the Mytilidae (*Mytilus*, *Lithodomus*, *Modiolaria*) and to the allied genus of *Avicula* proper (exclusive of *Meleagrina*).
>
> They occur both in the larva and the adult, but only do not make their appearance in the former (*Mytilus*) after the formation of the first branchial filaments.
>
> They are situated at the base and on the axial face of the first filament of the internal branchial lamella, and are innervated from the cerebral centre. In the larva they are situated *outside* the posterior margin of the velum.
>
> They appear to be homologous to the larval eyes of Chitons, which are also outside the velum and at the sides of the cephalic region, but they are not homologous to the cephalic eyes of Gasteropods, which arise *within* the velar area.

Those Cretaceous Gryphaeas.

THE extreme variability of the Gryphaeas has always rendered them difficult of study, and in no place has this difficulty been more fully understood than in the Texan Region. It is therefore with considerable satisfaction that we call attention to the 151*st Bulletin of the United States Geological Survey*, in which Messrs. R. T. Hill and T. Wayland Vaughan have attacked the Lower Cretaceous Gryphaeas of the Texan Region and evolved some order out of chaos. These mollusca

occur in countless thousands, form extensive masses of indurated strata, the outcrop of which can be traced for many miles; they are sometimes used for road metal, or collected and burned for lime. They have been named and renamed, until their specific identity is hidden under a mountain of literature, and this mountain Messrs. Hill and Vaughan have at last removed. The authors find that certain forms of these Ostreidae possess very distinct specific characters, have definite geological horizons, and are of the greatest value in stratigraphic work. And this conclusion seems to be quite an usual one when people take the trouble to collect a sufficient number of individuals of any species, and do not content themselves by describing a single specimen or every minute variation as of specific value.

The Gryphaeas of the Texan Region are now reduced to six species, and of these six the authors give no less than 231 figures, thus affording an excellent opportunity for every one to see the variability among the species. The figures are excellent, and the paper may be recommended as a specimen of what is wanted in palaeontology in this country—namely, a careful and critical study of important types rather than mere descriptions of a jumble of more or less fragmentary and doubtful specimens.

The San José Scale.

THIS insect, the source of considerable loss and trouble in the United States, has apparently been localised as an inhabitant of Japan. At least Mr. Cockerell, Mr. Alexander Craw, and Mr. F. M. Webster have by careful search found it several times on trees received direct from that land. The latter of these authors has written a short paper in the *Canadian Entomologist* for July, in which he asks that a competent entomologist may now be sent to Japan to locate it, and to find the natural enemies of the insect so as to import them into America. As Mr. Webster points out, the expenses connected with such an investigation would be a mere nothing compared with the amount spent in trying to exterminate the scale in those localities in the United States where it has obtained a foothold.

A Warlike Entomostracan and a Decrepit Trilobite.

FROM the Chemung group of New York—that is, from strata of late Devonian age—Mr. John M. Clarke, the well-known palaeontologist, describes and figures a new Phyllocarid crustacean (*15th Ann. Rep. State Geologist, N.Y.*). He names it the bristling shrimp horrent with javelins (*Pephricaris horripilata*). Each valve is fringed with some two dozen spikes, which make a truly imposing show. There is, however, nothing unusual in the development of striking armature upon crustaceans and their allies. Witness, for example, the headpiece of *Hemiaspis horridus*, Woodward, the tailpiece in various species of the

trilobite genus *Cheirurus*, or the carapace of the modern *Lithodes arctica*. Among the terrestrial Isopoda, usually so smooth, *Cubaris aculeatus*, Budde Lund, breaks out into spikes all over its body. Sometimes the soft abdomen of a spider becomes a regular fortress of obdurate angles. The new Phyllocarid would look rather less formidable were its valves closed, in what one may suppose to have been their normal position. External pressure may account for their being spread so widely open. A sign and result of this pressure is probably to be seen in the strong diagonal groove which each valve in the fossil exhibits.

From the same group Mr. Clarke is now able to re-describe another important crustacean, if a trilobite be a crustacean. In 1888 he founded the species *Bronteus senescens* on "a very imperfect fragment of a pygidium." Now, he has had at command "two essentially entire specimens." As so often with trilobites, the entirety refers only to the dorsal view, but this enables Mr. Clarke to enter upon an interesting discussion of the structural variations within the genus *Bronteus*, as compared with the times of appearance of its several species. *B. senescens* is said to be noteworthy, not alone for the rarity of all trilobites at the horizon indicated, but as in all probability the latest representative of the genus. The specific name, therefore, must be understood to refer rather to the genus than to the species itself as "growing old." For the species is regarded by Mr. Clarke as "a survival, with appropriate time modifications, of the proper expression of the genus." Evidently the representative of *Bronteus* was doing its best to march with the times, but there must have been some revolutionary spirit abroad ruthlessly bent on ending the dynasty of the Trilobites. The Phyllocarids are still with us.

More North American Fresh-Water Copepods.

WE have lately received two further instalments of the *Bulletin* of the Illinois State Laboratory of Natural History (vol. v. 1898), a publication to which the attention of our readers has been called on several previous occasions. The first (pp. 225-270) contains a paper by F. W. Schacht upon the comparatively rare fresh-water Copepods belonging to the genera *Osphranticum*, *Limnocalanus*, and *Epischura*. In a notice of a previous paper by the same author on the closely allied but much commoner genus *Diaptomus* (*Natural Science*, xii. p. 300), it was pointed out that America possesses, so far as that genus is concerned, a very characteristic fauna—not a single one of its species, for instance, being known on this side of the Atlantic. It appears that the same phenomenon is almost equally true of the remainder of the forms included in the family *Centropagidae*, now under consideration, for of the five American species dealt with, only one, *Limnocalanus macrurus*, Sars, is known to occur outside North America. In this case the animal is capable of living in both fresh and salt water, so

that the Atlantic probably presents no barrier to its passage from Europe to America, and *vice versa.*

The paper gives keys and descriptions of the very peculiar and interesting forms coming within its scope, but unfortunately it is not accompanied by any figures. It may be perfectly true, as stated, that "the species treated may be identified by figures already published," but this information is more tantalising than useful.

The Biology of the Victorian Era.

THAT the Liverpool Biological Society is as vigorous as ever is evident from the twelfth volume of its Proceedings and Transactions, which is full of interesting material. It begins with an inaugural address by Mr. Isaac C. Thompson on "Advances in Biological Science during the Victorian Era." This was a large order for one lecture, and Mr. Thompson's courage cannot be doubted. The result is a very delightful retrospect, though it lacks that completeness of outlook which we find, for instance, in Huxley's masterly sketch of an even wider subject—the Science of the Victorian Era. The bulk of Mr. Thompson's address is devoted, as is just, to evolution doctrine, and Darwin's work fills up so much of the picture that many great achievements have been crowded out. We miss, for instance, any recognition of such distinctive advances as the study of the cell, the conception of germinal continuity, the "protoplasmic movement" in physiology, the beginnings of physiological embryology, and many more. We sometimes wonder if there is not a hint of megalomania in much of our talk about "evolution," when even the foundations of the doctrine are still so far from secure. But the picture given in this address is so pleasant and vivid that it seems ungracious to complain that there are not more figures in it. There are visible figures, too—an interesting innovation—for the paper is illustrated by photographs of Charles Darwin, Erasmus Darwin, Cuvier, Edward Forbes, Wyville Thomson, Huxley, Pasteur, Spencer, Haeckel, Wallace, Weismann, Lister, and Herdman.

A Half-Century of Evolution.

As the wonderful century draws near its end we shall be deluged with retrospects, and truly these arbitrary time-boundaries may have their use in stimulating a feeling for history. It is to be hoped, however, that the note of jubilation which has already been loudly sounded by some will be softened by criticism, and that more will follow Mr. Wallace in recording the century's failures alongside of its successes. In his address to the section of zoology on the occasion of the fiftieth anniversary of the American Association for the Advancement of Science (August 1898), Prof. Alpheus S. Packard seems to have sought the *via media*, but we are not sure that he has always kept to

it. The first part of the address is entitled "A Half-Century of Evolution." He says that "a reasonable and generally accepted solution has been reached" of the problem "How did living beings originate?" "the evolution doctrine is based on the inductive method," though "biology is not an exact science"; "every department of intellectual work and thought has been rejuvenated and rehabilitated by the employment of the modern scientific method," and so on. Yet after this optimism, as it seems to us, he goes on to give a luminous sketch of the present conflict of opinions in regard to the very fundamentals of evolution doctrine, and he sums up: "With all these theories before us, these currents and counter-criticisms in evolutional thought bearing us rapidly along, at times perhaps carrying us somewhat out of our depth, the conclusion of the whole matter is that in the present state of zoology it will be wise to suspend our judgment on many theoretical matters, to wait for more light and to confine our attention meanwhile to the observation and registration of facts, to careful experiments, and to repeated tests of mere theoretical assumptions." This may be very sound advice, but it is rather a cold douche after the warmth of congratulation in which the author elsewhere indulges.

Prof. Packard seems to us to make a mistake in his historical summary, when he says "a third school or sect has arisen under the leadership of Weismann, who advocates what is in its essence apparently a revival of the exploded preformation, encasement, or 'evolution' theory of Swammerdam, Bonnet, and Haller, as opposed to the epigenetic evolutionism of Harvey, Wolff, Baer, and the majority of modern embryologists." Our reading of the history would lead us rather to say that Weismann differs as thoroughly from Bonnet as Hertwig from Harvey. The modern epigenesis differs *toto coelo* from that of the ancients. Are Prof. Whitman's essays not read in America?

Is Telegony a Mare's Nest?

FOR some years Professor Cossar Ewart has been making experiments which bear upon the vexed question of telegony, or the supposed influence of a previous impregnation upon subsequent offspring. As may be remembered, he started with the colt Romulus, the offspring of a Rum pony mare (Mulatto) by a Burchell zebra stallion (Matopo). Romulus has markings quite different from those of his sire, and rather resembling the Somaliland zebra. In 1897, Mulatto had a grey colt foal to a grey Arab stallion, and this foal showed at first some subtle markings slightly suggestive of zebra-influence. More careful examination of the skin after death showed that the hints of stripes were merely due to dispositions of the hair. In short, the experiment furnished no evidence in support of the hypothesis of telegony. In another case, a skewbald pony mare had, by the zebra, a hybrid which was fairly well marked, and by a bay Shetland pony a second foal

which almost exactly resembled its dam. In other cases similar negative results were obtained, any remarkable peculiarities that occurred being interpretable rather as reversions provoked by hybridism, than as furnishing any evidence of telegony.

In a paper on "Reversion in Birds and Mammals," read before the Royal Society of Edinburgh on December 5th, of which no adequate report has yet reached us, Professor Ewart summed up the results of a long series of experiments in crossing. He showed that reversion does not invariably follow crossing; thus the offspring of Galloway and Highland breeds of cattle might be indistinguishable from pure-bred Galloways, while a cross between a pure white fantail pigeon and a blue pigeon resulted in an intermediate form, with the colour of the fantail and the build of the pouter. On the other hand, he showed that crossing is *often* followed by reversion, as in the case of a cross between an Archangel and a White Fantail, which resulted in a bird exceedingly like a Blue Rock. But we wait impatiently for something better than a newspaper report of these experiments, which are as important as they are interesting.

A Study in Hybridism.

It is a far cry from horses to sea-urchins, but the phenomena of hybridism in the two sets of cases seem to be in some respects very similar. In his paper on "The Relations between the Hybrid and Parent Forms of Echinoid Larvae" (*Phil. Trans.* Series B, vol. cxc. (1898), pp. 465-529), Mr. H. M. Vernon shows that various species—*Strongylocentrotus lividus, Sphaerechinus granularis,* and *Echinus microtuberculatus*—are not separated by any rigidly-fixed physiological barrier. In fact, there is a general capacity for hybrid-fertilisation. In one case (viz. *Echinus* ♀–*Strongylocentrotus* ♂) cross-fertilisation takes place with greater ease, and produces larvae of larger size than does direct fertilisation.

In most cases the larvae are of the maternal type, but paternal and intermediate types also occurred. But the most interesting result is the evidence of a connection between the relative maturity of the germ-cells and the characteristics which find expression in the hybrid larvae. "The *Strongylocentrotus* ♀–*Sphaerechinus* ♂ hybrid is only formed at the time when the *Strongylocentrotus* ova have reached their minimum of maturity; whilst in the case of the reciprocal hybrid it is shown that as the maturity of the *Strongylocentrotus* sperm increases, it is able to transmute first a portion and then the whole of the hybrid larva from the *Sphaerechinus* to its own type. In other words, the characteristics of the hybrid offspring depend directly on the relative degrees of maturity of the sexual products." It seems as if we might, through such admirable researches as Mr. Vernon's, be able some day to invest with some reality the subtle conception of intra-germinal struggle.

Variation in a Sea-Anemone.

MR. G. H. PARKER has sent us a note on "The Mesenteries and Siphonoglyphs of *Metridium marginatum*," extracted from the *Bulletin* of the Museum of Comparative Zoology at Harvard (xxx. No. 5).

A second title for this important little paper might have been "A Warning."

The more we learn about the fixed or sedentary forms of animal life the more difficult does it become to separate the species by characters which can be relied upon as being tolerably constant. Many new species, new genera, and indeed some new families must inevitably be unmade again, when we know more about the limits of possible variations which may occur among the zoophytes. The results of Mr. Parker's observations on the single species of sea-anemone (*Metridium marginatum*) bring home to us more emphatically than any previously published papers the hazardous nature of the risk we run in proposing a new specific name for an anemone on the strength of the examination of a single specimen or indeed of half a dozen.

The group Hexactinia to which *Metridium* belongs was until recently supposed to possess two of the ciliated grooves, termed siphonoglyphs; but in *Metridium* only 41 per cent were diglyphic while 59 per cent were monoglyphic. Again, the name Hexactinia implies a certain constancy in the number of the pairs of mesenteries, but in *Metridium* there may be any number from three to eleven pairs, and one indeed was found with as many as fourteen pairs.

It is not necessary to follow Mr. Parker further into his statistics. It is an important contribution to the study of variations he has sent to us, and may have arrived in time to serve as a useful warning to those engaged in the systematic study of the sea-anemones.

Sensitive Protoplasm in Plants.

THE streaming movement of the protoplasm in the internodal cells of *Chara* with which botanical students are familiar, is the subject of a recent paper by Dr. Georg Hörmann, issued in book form by Mr. G. Fischer of Jena, under the title "Studien über die Protoplasmaströmung bei den Characeen" (79 pp., with 12 figures; price 2 marks). Dr. Hörmann has studied the arrangement of the currents in the various parts of the plant—leaf, root, and cortical cells—their relation to cell-division and their behaviour under various external stimuli—mechanical, thermal, electrical, and others. From its behaviour to electrical stimuli and comparison with the behaviour of muscle and nerve fibres, the author concludes that the stimulus-conducting substance in a cell of *Nitella*, and in a fibre of nerve or muscle, contains a common fundamental structural item. The nerve fibre substance is purely conductive; that in the *Nitella* cell is associated with a streaming mechanism, that in the muscle fibre with a contractive mechanism.

A New Species of Revolving Alga.

In his studies on the Plankton of the Illinois river (*Bull. Illinois Lab. Nat. Hist.* v. 1898, pp. 273-293, 2 pls.), Dr. C. A. Kofoid deals very fully with a new species of alga (*Pleodorina illinoisensis*) belonging to the *Volvocineae*. This form consists of an ellipsoidal coenobium, about $\frac{1}{200}$ inch in long diameter, containing normally thirty-two biflagellate cells arranged in five rings around the periphery of the hyaline gelatinous matrix. In common with most if not all the genera of the *Volvocineae*, e.g. *Pandorina*, *Eudorina*, *Volvox*, one pole of the colony is practically always directed forward in locomotion. The cells at this anterior end, however, not only differ from those towards the posterior pole, in that, as in the genera just mentioned, they are provided with larger red pigment spots, but four of them, the so-called vegetative cells, are much smaller than the remaining twenty-eight gonidial cells. The species, therefore, is especially interesting on account of its well-developed structural and physiological polarity. It also confirms the opinion expressed by W. R. Shaw, who founded the genus, that *Pleodorina* occupies an intermediate position between *Eudorina* and *Volvox*, although nearer the former.

The Corundum of India.

Rubies

In these days of the manufacture of artificial rubies it is satisfactory to get reliable information upon the existence and mode of occurrence of the natural stone.

The well-known "Manual of the Geology of India" being out of print, a new edition of the portion dealing with general geology was issued in 1893. The portion descriptive of the economic minerals was not at that time re-edited, but is now to be issued in the form of a series of separate papers, each dealing with a single mineral. The first of these is a most elaborate and exhaustive memoir by Mr. T. H. Holland, Deputy Superintendent of the Geological Survey of India, entitled *Corundum* (Calcutta, 1898, sold at the office of the Geological Survey).

This paper tell us all that is known about the geological occurrence and geographical distribution of Indian Corundum, and gives much information also about the uses to which it is applied. The most important section is that relating to the geological history of the mineral; special attention is called to the fact that it is found associated both with basic and with acid rocks. The author is disposed to the view that in not a few instances it was an original constituent of the rock, just like spinels and other oxides, and not necessarily an alteration-product or a metamorphic mineral. In particular, a felspar rock in the Coimbatore District, Madras, contains unaltered corundum which shows no evidence of secondary origin. It is well known that corundum can be crystallised out from certain slags which contain an excess of alumina.

Mr. Holland's memoir is a remarkably complete and thorough piece of work, and we hope that the Director of the Geological Survey of India will be able to issue a number of monographs worthy of association with this the first of the series.

Abstracts of Papers before reading.

It is a frequent complaint that the title of a paper to be read before a society, as issued in the circular convening the meeting, affords but little clue to the subject matter. This not infrequently keeps away many who, did they know the subject of the paper, would endeavour to attend and help forward a discussion. Some societies make it a rule to print the paper in advance, and circulate the full paper, or an abstract, to those likely to be interested in the subject, and these societies invariably secure a good discussion, at once useful to the author and to the society. We are glad to note that in the circular issued by the Geologists' Association of London for their December meeting, this course has been followed for the first time. The paper is entitled *Contributions to the Geology of the Thames Valley*, by A. M. Davies, and the abstract of contents of the paper, no doubt supplied by Mr. Davies, is as follows:—

> This is a stratigraphical paper dealing mainly with the beds within the Kimeridge Clay and the Gault in Bucks and Oxon. The most important new observations recorded are (i.) the Presence of Purbeck Beds N. of Haddenham and N. of Towersey; (ii.) the Non-existence of the Gault Outlier mapped N.E. of Haddenham; (iii.) the Presence of Portlandian Beds between the Shotover Ironsands and Kimeridge Clay at Littleworth, near Wheatley. The Author will exhibit maps, sections and specimens, and Mr. J. H. Pledge will exhibit photographs in illustration of the paper.

It is often quite impossible for an author to describe his paper in his title, though such a course is obviously to be desired, and we hope the Association will see its way to continue the abstracts, whenever such a course seems desirable to the Secretary. There are many other societies which might well follow suit.

A Slight Misunderstanding.

In a recently published volume on "Degeneracy" (Contemporary Science Series, 1898), of which we shall have more to say afterwards, Dr. E. S. Talbot says that "Weismann has practically abandoned the essential basis of his position by admitting that maternal nutrition may play a part in determining variation. He now asserts that the origin of a variation is equally independent of selection and amphimixis, and is due to the constant occurrence of slight inequalities of nutrition in the germ-plasm. As acquired characters affecting the constitution of the parents are certain to affect the nutrition of the germ-plasm, it is therefore obvious, according to Weismann's admission,

that acquired characters or their consequences will be inherited. This is an emphatic though concealed abandonment of the central position of Weismann." But surely this misunderstanding of Weismann's position is inexcusable, and to slump "acquired characters or their consequences" is quite illegitimate. The illustrious author of the "Germ-Plasm" has made it quite clear that there is a very great difference between admitting that the germ-plasm has no charmed life, insulated from somatic influences, and admitting the transmissibility of *a particular acquired character*, even in the faintest degree. The point is this: Does a somatic modification, induced by functional or environmental change, influence the germ-plasm in such a way that the modification, or even a tendency towards it, is transmitted to the offspring? Far from abandoning his position in the "Germ-Plasm," Weismann made it stronger than ever. The first condition of criticism is to understand what one criticises.

Photography in National Museums.

In connection with our note on this subject last month, it will be of interest to our readers to quote the following remarks from the *Times* of November 24th, in regard to the remarkable collection of facsimile Tudor proclamations now on exhibition at the British Museum:—

> These facsimiles have been beautifully executed at the photographic establishment attached to the University Press, Oxford, which would have been unnecessary if the Museum had possessed a photographic department of its own. Great as is the historical interest of the collection, even this is second to the importance of its exhibition as an object-lesson of the value of photography to great libraries and repertories of archives. There is nothing, from the priceless books and MSS. down to parish registers, which cannot by photography be reproduced and ensured against destruction and decay. With an efficient international system every country might possess every document illustrative of its history or its national life in the past. To this end, however, it is essential that the photographic atelier should be national, and connected with some public institution, for then, and then only, can the photographer be a salaried officer, and expense thus be reduced to a *minimum*. The trifling public outlay would be nearly, if not altogether, covered by public patronage. It is a matter for much congratulation that the first important step to demonstrate the utility and practicability of so great an object should have been made by the British Museum.

These remarks apply equally well to "types" or other subjects in Natural History.

Physiology of Reproduction.

The experimental examination of the physiology of reproduction in the lower members of the cryptogamic series is a study of comparatively recent date, opening a wide field of important investigation. Most of the definite knowledge we as yet possess of this complex and difficult subject we owe to the labours of Professor Klebs, who,

continuing his well-known researches on the conditions which determine the reproductive processes in thallophytes, has recently published (*Jahrb. f. wiss. Botanik*, Bd. xxxii.) a paper describing the effect of environment on the formation of sporangia and zygotes respectively in *Sporodinia*, one of the Mucorineae. This mould is peculiar, in that both reproductive organs arise from similar primordia, and, according to Professor Klebs, the determining factor, other conditions being equal, is to be found in the amount of transpiration taking place from the surface of the plant, and this in its turn depends naturally on the amount of moisture present in the surrounding air. So rigidly is this the case that in less than twenty-four hours he was able to determine at will whether sporangia or zygotes should be formed, simply by opening or closing the flasks in which the fungus was cultivated on discs of carrot, or on plumjuice-agar, both of which are soils suitable for its growth, though its natural habitat is the decaying cap of the larger toadstools. So long as the relative moisture within the culture chamber does not exceed 65 per cent, sporangia alone are formed, while if it rises above 70 per cent zygotes appear in increasing numbers till absolute saturation is reached. The most favourable conditions for the formation of zygotes are found in the stagnant layer of saturated air which always hangs over the plants in a still atmosphere, and in which any evaporation taking place from the surface of the hypha must be due solely to the temperature of the living substance being slightly higher than that of the surrounding medium. A current of air, even when nearly saturated with moisture, disturbs this layer, and thus tends to promote the formation of sporangia quite apart from any consideration of an improved oxygen supply, which indeed appears to exert but little influence.

The formation of zygotes seems to be unaffected by changes of temperature between a minimum of 6° and a maximum of 26° C., so long as the relative moisture remains constant, but above the higher limit the increasing transpiration induces sporangial development at the expense of zygote formation.

The nutrition of the fungus also influences the formation of reproductive organs. Thus starvation promotes the development of sporangia, not as might be expected of zygotes, and the same result follows the employment of such purely nitrogenous food materials as peptone, albumin, etc. On the other hand, certain carbohydrates such as cane-sugar, maltose, glycerine, dextrine, etc., favour the production of zygotes, while other substances belonging to the same series, like arabinose, lactose, inuline, etc., promote the formation of sporangia alone. The addition of peptone to the above-mentioned carbohydrates does not in most cases influence the result. The acid salts of certain organic acids, especially acid malate of ammonia, tend to the production of zygotes, while the neutral salts of the same acids promote only vegetative growth.

ORIGINAL COMMUNICATIONS.

Funafuti: The Study of a Coral Atoll.[1]

By W. J. SOLLAS, M.A., LL.D., D.Sc., F.R.S., *Professor of Geology and Palaeontology in the University of Oxford.*

By far the largest portion of the untrodden surface of our planet is formed by the floor of the Pacific Ocean. Submerged at an average depth of over 1000 fathoms, it lies out of reach of the geologist's hammer for all time, and for the present at least is inaccessible to the diamond drill.[2] The geology of an almost entire hemisphere is thus the secret of the Pacific.

"It is the nature of a God," Bacon quaintly remarks, "to conceal a thing, it is the glory of a man to find it out," and certainly there would seem to be few secrets in Nature to which a clue has not somewhere been left for those who have virtue to discover it.

The mountainous margins of the ocean, still young and actively moving, may doubtless furnish us with many precious hints, but it is to the multitudinous islands, which in serried rows like the tops of submerged mountain-chains extend across it, that we must turn in search of the true guiding thread.

Some of these islands, like New Zealand and New Caledonia, are in many important respects similar to our own, and seem to be the surviving fragments of a lost continent, which has fallen into ruins and sunk beneath the waves. Others, such as the Sandwich Isles and Fiji, are also of a kind long since familiar to us, clusters of volcanic cones which, like Stromboli and Vulcano of the Mediterranean, rise from the depths of the sea.

In addition to these, however, there exists a third and strange kind of islands, restricted to the torrid zone, and known to the daring mariners of the Elizabethan period as "low" islands, a name well deserved, since few of them attain a greater elevation than many of the

[1] Being the Friday evening discourse delivered before the British Association at Bristol, 1898.

[2] Professors John Joly and Edgeworth David think it may be possible by suitable machinery to bore a hole in the floor of the deep sea.

pebble beaches which fringe our own coasts: few indeed so great, the loftiest summits of most not exceeding the insignificant height of 10 feet. Owing to this fact they are scarcely visible till a ship is close upon them, and the first glimpse of a low island presents itself as a thin dark-green band, which separates the deep azure of the sky from the still deeper blue of the sea: with nearer approach a cream-coloured streak inserts itself below the green and is instantly followed by a line of dazzling snowy white, which is soon recognised as the fringe of surf which marks the boundary of the sea. Sailing nearer, the streak of cream-colour becomes the island beach, and the zone of green resolves itself into a mass of luxuriant vegetation, over which the feathery crowns of the graceful cocoa-nut palms, towering to a height of 80 feet, wave indolently in the sea-breeze.

As the details of this gracious scene, rising like an apparition from the deep, unfold before the eyes, one seems to gaze on some island of enchantment, and with the music of the surf thundering in one's ears one thinks of the Tritons sounding the loud conch, and half expects to "see old Proteus rising from the lea!"

If it be with surprise that we first make the acquaintance of these islands the feeling is in no degree abated with closer familiarity; from beginning to end their whole story is a chapter of surprises.

Mariners soon learned to dread the surf-beaten shores, for they could find no anchorage within a safe distance of the breakers, the sides of the island descending precipitously to great depths within a few hundred yards of the coast; and within this distance a reef of rough and rugged rocks forms the shelving floor of the sea. A barque once driven on to this heels over, with its deck facing the pitiless waves, and is swept clean from stem to stern.

Bristling with dangers on the outside, the island conceals within itself a spacious inner sea or lagoon, into which, through dangerous passages, a ship may make its way, and once there securely ride out the most destructive storm. The island thus differs from most others in being hollow in its midst: a mere rocky rim to a sea-lake, which may be as much as 60 or even 100 miles across, and 60 fathoms deep, though 20 fathoms is more usual. From this feature the islands are known, not only as "low" islands, but as "lagoon" islands. The shores of the lagoon are bordered by a smooth, gently sloping beach of flesh-coloured sand, over which the wavelets fall faintly: and palms and laurel-like shrubs growing down to the water's edge are reflected in its crystal margin.

When the voyager first set foot on this strange new land it was a fresh surprise to him to find it peopled. The inhabitants, usually graceful and prepossessing in appearance and amiable in manners, came timidly forth to welcome him, speaking a language full of soft vowel sounds, which has been aptly styled the Italian of the Pacific. In some cases, particularly when the natives were not red men but

black, they showed less favour to strangers, and the islands sometimes became the theatre of bloody strife.

Besides man, whose presence is an additional problem of the islands, no other mammals are indigenous, their place being taken by various land crabs and spiders of many kinds.

An examination of the rocks of a low island reveals another singular feature: save for a few fragments of pumice, brought from distant volcanoes by sea-currents and cast by the waves upon the strand, they present us with but one kind of material, carbonate of lime, which has been extracted from solution in the sea, and built up into a diversity of solid forms by the agency of organisms,—plants and animals, of which the most conspicuous are corals. Thus but one kind of rock enters into the constitution of the island,—and this is limestone: of granite, slate, sandstone, clay, such as we are familiar with at home, there is none: all is limestone, whatever you see!

The interest of this fact is enhanced by another. Repeated investigation has proved that the island is not merely a residuum, a mortuary of calcareous organisms, but that it is still alive and in active growth. A profusion of gaily tinted corals forms reefs within the lagoon, and the whole of the shelving platform, which descends from the surf to a distance of 20 or 30 fathoms below the sea, is alive with them: this platform is indeed the true growing surface of the island.

Corals, by reason of their considerable size and brilliant colours, first attract the attention of the observer, and hence, although numerous other kinds of creatures collaborate with the corals in the construction of the reef, these islands are known not only as "low" islands and "lagoon" islands, but also as "coral" islands, or more particularly as "coral atolls."

The remarkable discovery that coral atolls consist of the remains of animals and plants of precisely the same kinds as those which are at present adding to its substance, excited general interest, and led to many fantastic speculations, which need not now be recalled. The state of opinion at the beginning of this century may best be learned from the works of the poet-naturalist, Chamisso, who may probably be more widely known as the author of *Peter Schlemihl's wunderbare Geschichte* (The Story of the Man who sold his Shadow) than as an investigator of coral reefs. In a description, which even in the light of the most recent research must still be pronounced excellent, Chamisso (Fig. 1) speaks of atolls as table-mountains which rise steeply from great depths. The summit of the table-mountain is always under water, and is covered by the living reef, which surrounds its margin as a broad platform, and rises to the

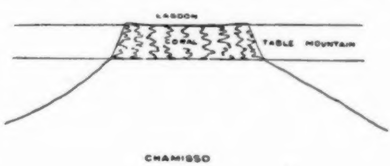

Fig. 1.

level of low tides. Sandbanks resting on this form the dry land. Since, he observes, every particle of the atoll which lies within the reach of observation consists of coral, it is only just to conclude that the whole structure, including the table-mountain, is formed of the same material. Not perhaps a strictly logical conclusion, yet, as events have proved, in the main correct.

Chamisso's opinion was not destined to remain long unchallenged, for two famous French naturalists—Quoy and Gaimard—asserted, as the result of their observations, that the coral-rock of an atoll is only skin-deep, *i.e.* it forms, according to them, a mere superficial crust, not more than about 25 feet in thickness; the rest—Chamisso's "table-mountain"—being, on this view, of volcanic, or at all events of inorganic, origin.

Few of the arguments by which it was attempted to sustain this erroneous conclusion strike one as being very satisfactory, but they include one highly important observation, viz. that reef-building corals do not live at greater depths than 25 feet below the level of low tides. Subsequent inquiry, while fully confirming the existence of a limit, has at the same time extended it down to a depth of as many as 25, or perhaps even 40, fathoms. Yet, even with this modification, the unexpected discovery of Quoy and Gaimard seems to stand in flagrant contradiction to the views of Chamisso. If corals cannot grow below a depth of 25 fathoms, how could they possibly have built up islands of over 100 fathoms in thickness?

The answer to this question, as is well known, was given by Charles Darwin. If we admit the truth of both the apparently conflicting statements, it is obvious that the corals at the base of a reef 100 fathoms in thickness must have been situated within the limit of 25 fathoms at the time they were alive. But in order to bring them within this limit it is only necessary to suppose that the foundation on which they grew originally stood 75 fathoms nearer the sea-level than it does now; or, in other words, that since the lower layers of the reef were alive and flourishing, the ground which supported them has sunk 75 fathoms deeper in the sea. No fact is better established than the rise and fall of islands situated in mid-ocean, and thus there is nothing antecedently improbable in this supposition. But once grant it and Darwin's explanation of atolls naturally follows. Thus let *a* be an island with its summit rising 100 fathoms above the sea; let its shores become peopled with corals, which extend seawards down to the limit of 25 fathoms, beyond which, as we admit, they cannot proceed: a reef is thus started, which will continue to grow, rising upwards till it reaches the level of low tides: when this is attained upward growth will cease, and the reef will begin to pass into decay, from the shore-edge outwards. So long as the island remains stationary, neither rising nor falling with respect to the sea-level, this is practically all that will happen, and the final result is a reef not much exceeding

25 fathoms in thickness (Fig. 2, first stage). But let us next suppose that the island begins slowly to sink into the sea, carrying the reef with it; the upward limit to the growth of the corals will be displaced; they will commence to flourish afresh, and the reef will continue to extend upwards till the level of the low tides is once more encountered, and growth again arrested. This process of submergence and upward growth may of course be repeated indefinitely, and by the time the island has descended 50 fathoms below its original position, the reef will have acquired a corresponding thickness. In such a case the unfavourable conditions to coral growth which prevail on the inner side of the reef, together with the retreating slope of the flanks of the island, will have led to the formation of a channel of sea-water between the reef and the shore (Fig. 2, second stage). Finally, let the submergence of the island continue till it is completely swallowed up by the sea, not a vestige of its summit remaining to mark its place; the upward growth of the corals, constantly proceeding, will bring them once more to the level of low tides, and the result will be the formation of a ring-shaped reef surrounding a central lagoon, or, in other words, of an atoll (Fig. 2, third stage).

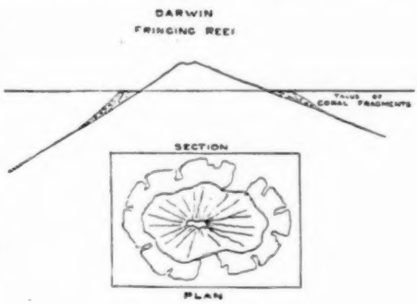

FIG. 2.—First Stage.

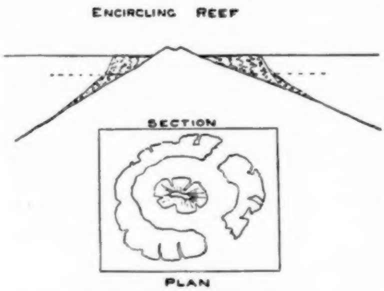

FIG. 2.—Second Stage.

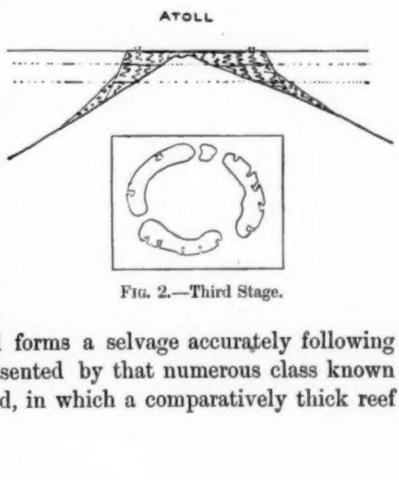

FIG. 2.—Third Stage.

If this hypothetical scheme of the progress of events correspond to the facts, we may expect to find its various stages still represented among the numerous islands of the Pacific; and this, as Darwin endeavoured to show, is clearly the case. The first stage, in which the reef is no more than 25 fathoms thick, and forms a selvage accurately following the margin of the land, is represented by that numerous class known as "fringing" reefs. The second, in which a comparatively thick reef

surrounds an island with an intervening saltwater channel, is illustrated by another class, known as "encircling" or "barrier" reefs. In these, as we might expect, the form of the reef is only remotely related to the contour of the enclosed island, the valleys of which present that fiord-like character so suggestive of sunken land. The last stage is that of the atoll itself.

The excellence of Darwin's theory lies in this, that it explains all the essential features of an atoll on one simple assumption. It is inconsistent with no known fact, and as additional discoveries have been made it has not required to be supplemented by fresh hypotheses. It is not like a Gothic structure, supported by flying buttresses and other *tours de force*, but rather resembles some noble Italian tower, which rises from its base, straight, simple, and self-sufficing. It was no sooner given to the world than it commanded almost universal assent.

Nevertheless it has never been without a rival: even before Darwin published his celebrated work, Ainsworth[1] had suggested a different explanation. He rightly pointed out that Quoy and Gaimard had not established a limit for all reef-building organisms, and that although certain corals, such as they had observed, might be restricted to shallow waters, there might yet be others capable of flourishing at greater depths. If so, these deep-water organisms might be engaged in laying the foundations of an atoll on which the shallower-water forms might erect the superstructure (Fig. 3). This suggestion seems to have fallen still-born, but the notion of "laying the foundation" of an atoll was not destined to perish: it has been revived of late years by Sir John Murray, who, guided by his observations made when on board the "Challenger," was led to suppose that the submerged summits of deeply-sunken islands might be raised to within the limit of 25 fathoms, not by the upward growth of corals but by the incessant downward rain of minute organisms from the surface of the sea. The same agencies which were supposed to be spreading out a layer of chalky mud or ooze over the abyssal floor of the ocean were also imagined as engaged in piling a Pelion of mud on every submarine Ossa (Fig. 4).

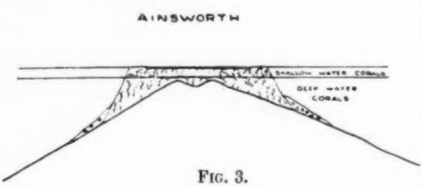

FIG. 3.

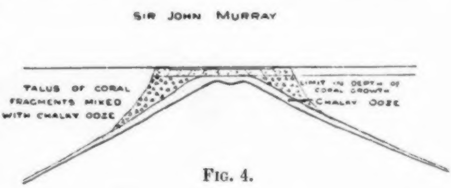

FIG. 4.

[1] G. W. Ainsworth, "Analysis of a Voyage to the Pacific and Behring's Straits, to co-operate with the Polar Expedition, performed in H.M. Ship *Blossom*, under command of Capt. F. W. Beechey, R.N., in the years 1825-28," *Geog. Jour.* vol. i. 1831.

The publication of Sir John Murray's views was followed by a long controversy, in which Darwin's theory was subjected to a most searching criticism. An impartial summary of the arguments arrayed on both sides of the question is given by Professor Bonney, in the last edition of Darwin's "Coral Reefs," and the general subject is treated in the fullest manner by Langenbeck, in a work entitled "Die Theorieen ueber die Entstehung der Koralleninseln und Korallenriffe" (Leipzig, 1890).

So far as the opposition to Darwin's views has come to count among its adherents a number of distinguished thinkers, it can only be regarded as having achieved a certain measure of success: a result not, to my thinking, to be wholly accounted for by the nature of the arguments employed; possibly in this as in similar cases, the ostensible objections are mere weapons of combat, while the real power has lain in the strong and subtle influence exercised by some general current of thought. Such a current is indicated in the tendency to a belief in what is spoken of as the Permanence of Continental Areas and Oceanic Basins.

According to Darwin, every atoll marks the site of a vanished island, but the atolls of the Pacific are so numerous that if one imagines all the islands they represent as summoned back from the "vasty deep" and restored to their original position above the sea, they will constitute a very considerable tract of land, and this situated in the very middle of the Pacific Ocean. Such a prospect could not fail to be unpleasing to those who believed in the immutability of the ocean.

Of late years, however, this doctrine of "permanence" has begun to look a little threadbare. In a theoretical restoration of the distribution of land and sea during the Jurassic times, Neumayr has treated it with scant consideration, since he represents the North and South Atlantic, as well as the Indian Ocean, as then to a great extent occupied by land, and it is now very generally supposed that this land did not disappear to make way for existing seas till a comparatively late period in the history of the earth. Bold as Neumayr showed himself in the treatment of these oceans, he had not the temerity to take liberties with the Pacific. This he and geologists in general are disposed to regard as having maintained its existing features from a very early period: of this ocean, and of it alone would they exclaim, "Such as Creation's dawn beheld, thou rollest now."

Darwin's theory, as we have seen, does not hesitate to recall to existence land in the middle of even this ocean; this is its unforgivable offence—it lays sacrilegious hands on the Pacific, and thus attacks the doctrine of "permanence" in its stronghold.

While the recent controversy on Darwin's theory was at its fiercest, and both sides seemed equally persuaded that the truth was theirs and must prevail, it occurred to me that a simple solution

might be obtained by sinking a bore-hole through some well-characterised atoll, and thus obtaining specimens of the material of which it is composed, down to a depth considerably greater than that at which corals are supposed to build. How would this illustrate the question? Allow me to employ a homely illustration: buyers of cheese are not, I presume, naturally more suspicious than other persons engaged in trade, but they are unwilling to trust too much to mere outward appearance; they are not inclined to adopt the argument which commended itself to Chamisso in a parallel case, that because there is good cheese on the surface it must be good cheese all through: consequently by means of a boring instrument, called a scoop, they make a hole through the cheese and bring out a core or cylindrical rod, in which the several strata of the material, if there be more than one, are displayed in their true thickness and natural position. The atoll is our cheese, which we propose to sample with a complicated kind of scoop called a diamond drill. This should provide us with a core in which the various layers of the coral reef should be faithfully represented. Should Darwin's theory prove correct, the core will contain the remains of reef-building corals as far down as the reef extends; if, on the other hand, Sir John Murray's explanation make a nearer approach to the truth, layers of chalky ooze will be present at depths greater than that of the limit of coral growth (Fig. 5).

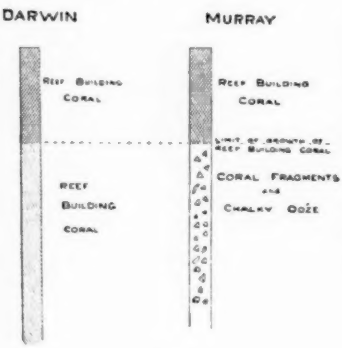

FIG. 5.

No one who has any notion of the extraordinary thoroughness with which Darwin attacked this as every other problem that he investigated, will be at all surprised to learn that the same solution had already occurred to him, and in a letter to A. Agassiz (May 5, 1881) he sighs for "some doubly rich millionaire, who would take it into his head to have borings made in some of the Pacific and Indian atolls, and bring home cores for slicing from a depth of 500 or 600 feet." As the wished-for millionaire did not appear to be forthcoming, it appeared to me that the boring might be achieved in another way, by a method very familiar to this Association, I allude of course to a "Committee." On approaching Professor Bonney with a suggestion to this effect he warmly entertained the proposal, and in 1891 a strong Committee, including the most distinguished supporters and opponents of Darwin's theory, was formed, having for its object the investigation of an atoll by boring and other means.

Through the kind offices of Professor Stuart of Sydney we obtained from the Government of New South Wales the offer of the free loan of

a diamond drill. Our next step was to select an island for investigation. This was rendered an easy task through the invaluable assistance afforded by Admiral Wharton, whose extensive knowledge of coral-reefs renders him the most formidable of Darwin's opponents. At his suggestion our choice fell on Funafuti, one of the Ellice or Lagoon Islands, situated in the middle of the Pacific (lat. $8\frac{1}{2}°$ S.), seven days' sail northwards of Fiji. No better selection could possibly have been made. Not only is Funafuti an atoll of unexceptional character itself, but it belongs to a family of atolls all of equally unexceptional character; and these again to a system which includes the Gilbert and Marshall Islands, all of them excellent atolls. So far as these are all distinguished by the same characters, whatever may be found true of Funafuti will apply to all the rest.

The labours of the Committee of the British Association were then taken over by a Committee of the Royal Society, at whose request the Admiralty generously assigned to our assistance the "Penguin," one of H.M. gunboats, commanded by Captain Field, and stationed in the Pacific for exploring purposes. The Royal Society furnished funds to defray expenses, and the direction of the expedition was placed in my hands: two volunteers, Mr. Gardiner of Cambridge and Mr. Hedley of Sydney, were with my permission to accompany me.

We joined the "Penguin" and left Sydney on 1st May 1896, taking with us a boring party which had been selected for the work by Mr. Slee, the Government Inspector of Mines and Drills. Its foreman, Ayles, had acquired great reputation in the colony by his success in conducting boring operations of exceptional difficulty. On 21st May, after three weeks' voyage, we heard the welcome cry "Land ho!" and Funafuti was seen on the horizon. The ship was steered for the southern entrance; this was safely made, and we steamed into the noble lagoon. Flying-fish spurted from under our bows, and zigzagged in their darting flight around us; here and there in the midst of the blue waters green and purple shallows marked the site of growing coral patches. On the starboard side lay the beautiful island of Funafuti proper, its pale sands ablaze in the light of the tropical sun, its groves of palms cool with a refreshing green. A boat put off from the beach manned by a crew of copper-coloured natives, their black hair crowned with wreaths of *Gardenia* and *Hibiscus* flowers. They were soon swarming over our sides, bringing with them the solitary white trader of the island, who safely piloted us to anchor within a mile of the shore. Captain Field and a party immediately landed, and we went at once to pay our respects to the king, who, notwithstanding the narrow limits of his realm and the smallness of his nation, which numbers only some 240 souls, we found to be every inch a king. His Majesty received us with gracious dignity, led us into his palace, one of the few stone huts on the island, and seated us by his side on the daïs, which consisted of packing-cases.

The chief men sat round the walls on the floor, and smiling damsels, with large black eyes, ivory white teeth, and long black tresses floating loose, shyly presented us with freshly opened cocoa-nuts to drink, a civility which as inevitably attends a call in Funafuti as the afternoon cup of tea at home. We told our errand, and received permission to choose a site for boring operations. We then requested that a house should be built for us, and were promised that this should be done for the modest sum of £6. The reception ended, we proceeded to choose a site for the boring and for landing gear, and marked out the plan of our house; it was to measure 15 by 20 feet. We were anxious to have the building of this put in hand at once, and were assured that it should be ready for us by the afternoon of the next day. The East is supposed to be more fertile in promise than performance, and our expectation was that we should see this house when we did see it. Judge, therefore, of our surprise when on passing the same spot the day after we found a substantial structure already standing there. It had grown up like Aladdin's palace in a single night! The whole population had been employed on the work; the men had cut down trees and shaped them into poles, sunk these in the ground, and bound them together into a solid framework; the children had been set to gather palm leaves from the forest, and the women had woven these into mats, which were used to form both the walls and thatch of our dwelling. The result was an excellent house which served all our needs, protecting us from sun and storm during our residence of nearly three months. Not a nail was driven in its construction, all the joints being firmly made with cocoa-nut cord.

After contemplating the work with great satisfaction I left for a stroll, and returning an hour after was aghast to find our new house surrounded with smoke and flames! To my great relief it turned out that the conflagration proceeded from the surrounding bush, which the thoughtful natives had purposely set alight to prevent its taking fire by accident.

The work of landing gear and erecting machinery was set about vigorously; the crew of the *Penguin* toiled all day heroically in the burning sun, refreshing themselves at sunset in swimming matches with the natives; progress was so rapid that by 3rd June, not quite a fortnight after landing, the boring party were already at work (Fig. 6). So far all our plans had been carried out with expedition and success, and since "things done well and with a care" are said to "exempt themselves from fear," we may now safely leave our miners industriously boring while we take a walk across the island. Standing on the shore of the lagoon near the site of our boring, it is just possible to catch a glimpse of the palms on the opposite side, some ten miles away. The beach slopes so gently, that although the tide falls only about five feet it leaves a wide expanse of sand uncovered; this is a perfect warren of shore crabs (*Calappa*), which scurry along like blown thistle-down

and vanish into holes with mysterious suddenness. It is at night that these are most active, when they dig deep burrows in the sand, casting up conical hillocks at the entrance nearly a foot high, which give the beach the appearance of a miniature encampment. The sand is the famous "coral" sand; but on picking up a handful for nearer inspection we are surprised to find that it contains scarcely any coral; and so far from consisting of detrital material, it is almost entirely composed of the shells of Foraminifera, two species predominating, *Tinoporus baculatus* and *Orbitolites complanata.* From specimens collected on other atolls by the late Professor Moseley, and preserved in the University Museum at Oxford, it would appear that the sand at Funafuti

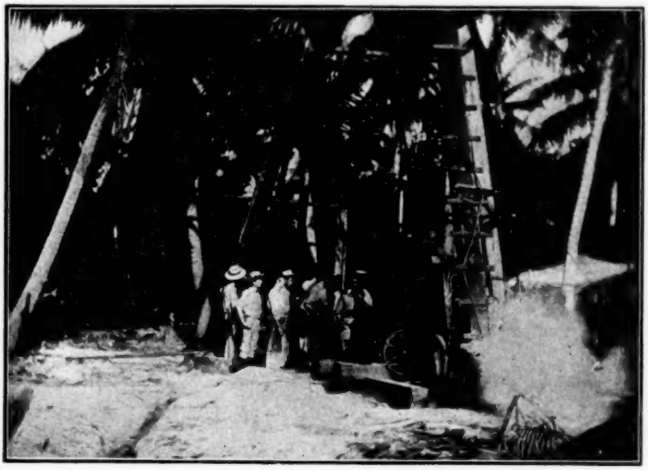

FIG. 6.—The Site of the First Boring, with Derrick and Machinery.

is by no means singular in this respect, and the term "coral" sand is only another instance of the "lucus a non."

The lagoon beach ends in a tiny cliff about a foot in height,[1] to the very edge of which sparse turf and vegetation of a larger growth extends; the land to which this cliff is boundary consists chiefly of small fragments of coral and shells of Foraminifera; it rises a little so as to attain a maximum height of 3 or 4 feet above high-water mark. In breadth it varies considerably, and where broadest the native village stands, with the church, large enough to contain the whole population, all church-goers, the school, mission-house, and palace. A row of graves, made tomb-like with slabs of coral, runs down the middle of the main street. The whole of this sandy flat is covered

[1] This applies to that part of the islet on which our house was built: in some places more considerable cliffs are met with, *e.g.* on one of the northern islets of Funafuti called Amatupu, where a conglomerate of coral pebbles forms steep faces some six feet or more in height.

with rich forest growth (Fig. 7), cocoa-nut palms in all stages, from the young plant just sprouting from the shell to the ancient of the groves, 80 feet in height, bearing heavy clusters of ripe fruit beneath its crown of feathery fronds; pandanus, with its strange adventitious roots and truculent sword-shaped leaves, broken in the middle; the laurel-like Nono (*Morinda citrifolia*); and the "Nya" tree (*Pemphis*), with its heavy stem of hard red wood, and delicate foliage. Ferns abound, and some brightly coloured flowering plants; an *Abutilon*, which puts forth fresh blossoms day by day; and a handsome bean, which trails through the forest, bearing large heart-shaped leaves and heavy racemes of lilac flowers.

The great robber-crab (*Birgus*), which feeds on cocoa-nuts and

FIG. 7.—Forest scene in Funafuti.

pandanus fruit, is at home here, and may be seen climbing the cocoa-palms by night. Other land crabs scramble through the fallen palm leaves which thickly strew the ground. Many of these are of the hermit kind, and one of them has a curious habit of croaking like a frog when captured. But no part of the island is free from land crabs; like rats and mice they are the universal scavengers; they undermined our house, attacked our tinned provisions, and one could not sit down to eat a cocoa-nut without some of these weird creatures gathering round to pick up the fallen crumbs.

As we continue our passage across the sand, the scene rapidly, even abruptly, changes its aspect; the place of the forest so rich and varied is taken by a grotesque growth of "Nya" trees, whose stubborn contorted trunks, strangely at variance with their dainty foliage, bar the way; struggling through these, one enters upon a savage plain, "horrid" with rugged fragments of blackened coral, and cumbered here

and there with huge boulders of coral rock some tons in weight.[1] At low water this desolate region is dry and burns in the sun, but as the tide rises sea-water oozes up through holes in the ground and covers it with shallow pools. Few animals live in this desert; spiders, that infest the "Nya" trees, and mosquitoes, that lie greedily in wait by day as well as night, are the chief that I bear in mind. Proceeding lengthwise along this plain, which lies in the middle of the island, it broadens out and passes into a muddy swamp, planted by the natives with taro, a delicious substitute for potatoes, and bananas, which one still reflects upon with pleasure; their fruit was our

FIG. 8.—*Heliopora* in the foreground, *Porites* beyond the Mangrove Swamp, Funafuti.

chief luxury, and we willingly paid for it at the somewhat exorbitant price of four fathoms of calico a bunch.

Farther on beyond the plantation, the depression becomes still wider, forming an extensive flat, partly margined by mangrove trees and *Hibiscus;* this was known to us as the mangrove swamp (Fig. 8). It is an interesting corner of the island. The floor represents the upper surface of a deal coral reef, composed partly of great masses of *Porites;* their flattened summits, standing some 8 or 10 inches above the floor, give them the appearance of a row of stepping-stones, and mark what was the level of low tide at the time the reef was living.[2] Radiating from these blocks as from a nucleus are vertical plates of the "blue

[1] One of these measured 6 feet by 5 feet by 4 feet.

[2] The last episode in the history of the island appears to have been a slight elevation of some four or five feet: at least I was led to this conclusion from evidence furnished by the "dead reef" of the mangrove swamp, by the "sea-stacks" or pinnacles of coral-rag of the tidal platform, and by the steep cliffs which in some of the islets border the lagoon.

coral" (*Heliopora coerulea*) which extend outwards, branching as they go, for a distance of 3 yards or more. Overlapping the reef lies a layer of consolidated coral breccia; it has suffered much from erosion by the sea, and bounds the inner side of the depression in cliffs 3 or 4 feet in height. A sheet of clear green water covers the swamp at high tide, converting it into a shallow lake, which as the tide falls empties itself through deep holes in the floor into subterranean passages, which freely communicate with the outer sea. The northern end of this depression is closed by coral breccia, and overgrown with mangroves; but farther on it recommences and extends through the remainder of the island, almost as far as its northernmost extremity, forming a discontinuous

FIG. 9.—A Raised Pinnacle of Coral.

narrow trough bordered by steep cliffs. This trough, and the depression to which it belongs, owes its origin in some degree to solution by sea-water.

We have deviated from our walk across the island to follow the course of its central depression, let us now return and resume our traverse. The blackened fragments of coral, resembling nothing so much as the clinkers of lava which cumber the slopes of Etna, continue seawards, and are loosely piled to form a gently rising ascent; so loosely piled that they often topple over at a touch, and afford very uncertain or even dangerous foothold.

Walking circumspectly, therefore, up the slope we soon reach the summit of a long ridge, and find ourselves looking towards the Andes, some thousands of miles away over the broad waters of the Pacific Ocean. We stand on the top of the "storm-beach," the loftiest region of our island, at the imposing altitude of 10 or even 15 feet, according

to the state of the tide. On the seaward face the storm-beach descends somewhat rapidly, and near its foot a sheet of hard consolidated coral-rag emerges from under it, to form a gently sloping platform, over which the tide ebbs and flows. In places this tidal platform rises in low cliffs, ridges, and pinnacles[1] of fantastic shape (Fig. 9), but for the most part it presents itself as a sheet of limestone, smoothed and polished by the wearing action of the waves. For about fifty yards from its seaward edge it is hollowed into a broad shallow depression (Fig. 10), not deep enough to be called a channel, and finally swells into a narrow rounded rim formed by the growth of a pink-coloured calcareous seaweed known as *Melobesia*. Beyond this rim, which projects above the sea at low

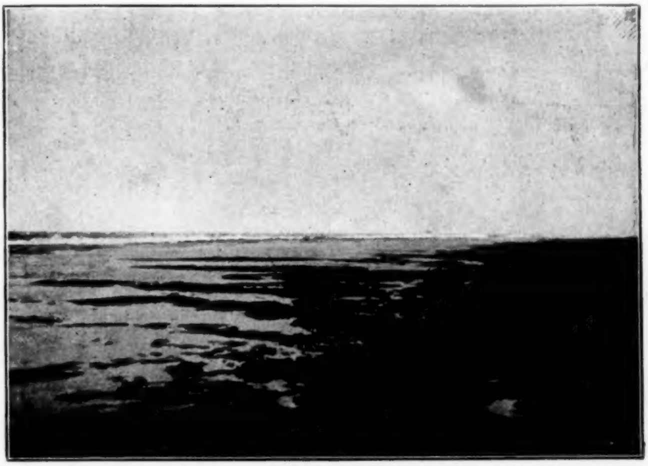

Fig. 10.—Funafuti on the Ocean Side.

tide, lies the growing surface of the reef, which is constantly submerged, so that under no circumstances are the corals which thickly cover it at any time exposed to the air.

Deep chasms gash the edge of the tidal platform, the continuation inland of the lanes of clear sea which wander through the growing reef; in these chasms a few corals may generally be found, their polypes sometimes brilliantly coloured and in full expansion.

The calcareous alga, previously alluded to as *Melobesia*, forms the lips of these chasms, and by its luxuriant growth may more or less completely roof them over, generally leaving one or more apertures, which act as blow-holes.

The ocean side of the reef is one of the pleasantest parts of the island: a cool breeze almost always blows there; and, under the welcome shelter of the palms and pandanus which crowd the summit of the storm-beach, one may watch the beautiful and impressive spectacle

[1] See note 1, p. 29.

below (Fig. 11): the ocean, of a deep majolica blue, rolls inwards in majestic waves, which suddenly grow gigantic as they approach the shore, towering in a wall of water above the reef; and then spring with a furious roar into a confusion of white foam, which seethes about the madder-tinted margin of *Melobesia*, rushes through the chasms of the tidal platform, and often spouts up through the blow-holes with sudden and explosive violence, like a kind of marine geysers. It is only on calm days that the extreme margin of the reef can be approached with safety. Such is the violence of the breakers that the tidal platform presents the appearance of an almost lifeless desert; a few green and brown seaweeds, little fish darting in the pools, occasional sea-snails with dense shells, and a few hermit-crabs heavily armoured, are all that

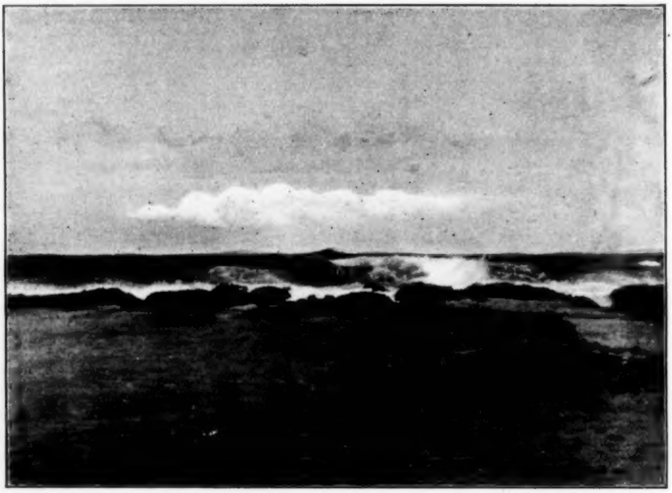

FIG. 11.—Tidal platform and margin of reef.

is seen at first glance. All the inhabitants of the tidal platform seem to stand in dread of the sea; even the active shore crabs (*Grapsus*) are afraid of it, and only venture in when inspired by their greater terror of the human form; even then they cling tenaciously with their many legs close to the sides of the rocky shore, and sidle off to land directly they fancy the enemy's back is turned.

The observer who trusted to first impressions, and judged the platform by its outer aspect, would fall into grievous error; it is by no means so dead as it seems. On breaking off a fragment with a hammer a new world of life is revealed; the rock is tunnelled through and through, as closely as it can be mined, by a variety of animals, which have taken to an underground life as a protection against the sea: worms, shell-fish, crabs, sea-squirts, and barnacles are to be found in these subterranean dwellings; they constitute a specialised

fauna of marine troglodytes, which might, if we wished to add to the burden of nomenclature, be designated the "Cryptone."

After this brief description of the superficial features of the atoll, we may next endeavour to trace the history of that part of it which rises above the sea and properly constitutes the land. The sheet of hard coral-rock, which we mentioned as cropping out beneath the storm-beach, can be traced into the interior of the island, where it forms the floor of the central depression; and again to the lagoon side, where it emerges to form the floor of the lagoon, and in many places the beach, or as well even a low line of cliffs. In the little islet of Pava, north of Funafuti, it is seen to extend continuously from one side of the land to the other—from the ocean to the lagoon.

We may therefore fairly conclude that this sheet of rock forms the solid base on which the land above it rests. It is composed mainly of slabs of coral, lying not quite horizontally, but overlapping like the tiles of a roof, with a slight inclination towards the ocean side of the reef.

These fragments have evidently been derived from the outer zone of growing coral. Before the land, as it now exists, was formed, the waves were incessantly engaged in tearing off fragments from the coral zone, and driving them across the reef into the lagoon, till a thick sheet of debris was the result. This became consolidated as it formed, partly by the growth of incrusting calcareous algae, and now forms the solid floor of the island.

Masses of broken corals, torn up and driven inland by the breakers, continued to accumulate after the formation of the floor; and thus that great pile of coral clinkers, which forms the storm-beach, has been and is still being built up.

On the other side, the wavelets of the lagoon have washed up smaller fragments of coral and foraminiferal shells, and thus the strip of land which borders the lagoon, and on which the village of Funafuti stands, has been produced.

The middle of the island—the great central depression including the taro ground and the mangrove swamp—is the remains of the original solid platform left exposed between the storm-beach on the one hand and the lagoon land on the other. Thus all that portion of Funafuti which stands above high tide has been cast up from the ocean and the lagoon, and this beautiful island, like another Aphrodite, has been born with the foam from the waves of the sea.

If this be the true history of the island, how then did it acquire its inhabitants? (Fig. 12). Did they climb upwards, like the corals, as the island was submerged, or did they arrive as flotsom and jetsom of the sea. As regards the natives there can be but one answer—they came by boat. In former days the Polynesians possessed excellent sea-going craft, in which they were accustomed to make long voyages, steering by the stars and other signs in the sky. They well knew how to preserve food by drying, and thus had no difficulty in provisioning for a cruise. The routes they followed in passing from island to island are

gradually becoming known to us; and have been indicated on a chart by Professor Haddon. Considering the remarkable similarity of language which characterises all Polynesia, from New Zealand on the south to the Sandwich Isles on the north, there can be little doubt that the migrations of these peoples must have taken place comparatively recently, and judging from tradition one might conjecture within the last seven or eight hundred years.

Thus long before the illustrious townsman of this city, Bristol John Cabot, had anticipated Columbus in his famous voyage to America, these navigators, whom we libel with the name of savages, were venturing on equally arduous explorations, with still more imperfect means at their

FIG. 12.—A Group of Natives, Funafuti.

command. It was not often, however, that long voyages of over a thousand miles were made of set purpose; too frequently they were the result of accident, as when frail canoes were overtaken by a sudden storm and driven at the mercy of the winds, sometimes to perish miserably, sometimes by good hap to land on undiscovered shores.

The Funafuti people seem some of them to have entered the island with intent, others are mere waifs and strays cast away by shipwreck on the reef. The prevailing stock is Samoan, with an admixture of Tongan. In bygone times the Tongans used to make periodical descents upon the island, after the fashion of the Vikings in early English history. The Tongans, however, came not only to kill but to eat their foes, a proceeding not wholly unintelligible among a people who knew absolutely of no other kind of meat. In justice to the copper-coloured races of Polynesia I hasten to add that cannibalism

was seldom the custom of this folk; wherever it is met with it may be taken to indicate the influence of black blood. So far as we know cannibals are almost always black people.

Returning to the boring party, which we left busily engaged. For nearly three weeks they worked by shifts continuously night and day, but at the end of that time, when the bore-hole was only 105 feet deep, their most arduous efforts failed to advance it further. The difficulties opposed by the nature of the ground—a mixture of flowing sand and obdurate boulders—were such that neither the good-will of the workmen nor the ingenuity of Ayles, the foreman, could contend against them, and there was no alternative but to abandon the undertaking.

Thinking that there might be a better prospect of success on the ocean side of the reef, we determined to make a fresh attempt there, and in two days, without the help of wheels and in a country without roads, we succeeded in transporting the bulk of our twenty-five tons of machinery across the island to a fresh site. The new boring commenced in hard rock and at first deepened rapidly. Before long, however, it entered a mixture of sand and boulders similar to that we had previously encountered, and after attaining a depth of 72 feet further progress became impossible. We left the island on 30th July, and on reaching Fiji had the mortification to learn that we had passed on the way a ship coming to our assistance with a fresh supply of machinery, which our friends in Sydney had promptly despatched on hearing of our difficulties.

Our attempt to penetrate the reef had proved a failure, but it was not wholly without result. It had revealed the nature of the material with which any subsequent attempts at boring would have to contend, and it had added one more surprise to the history of atolls, for no one had suspected that for a depth of over 100 feet the island would be found to consist of more sand than coral, or in other words, that the organisms which play the chief part in the construction of a coral reef are not corals, but Foraminifera!

The expedition had other objects in view besides boring. The next in importance was the investigation of the atoll by sounding. This was accomplished with complete success by Captain Field. Other atolls had been sounded before, but never before had an atoll been sounded with such accuracy and completeness as was Funafuti on this occasion. The form of the floor of the lagoon was made more exactly known than that of most lakes in the British Isles. The slopes of the flanks of the atoll were determined in four different directions, approximately at right angles to each other and running about N., S., E., and W. A study of these enables us to frame a clear picture of the general form of the atoll. It is a conical mountain with an oval base situated at a depth of about 2000 fathoms, measuring 30 miles in length by 28 in breadth. It rises at first with a very gentle slope but gradually grows steeper as it ascends (Fig. 13), till at a depth of 400 or 500 fathoms it begins to present precipitous faces, and above 130 to 140 fathoms is

crowned by the almost vertical cliffs of Chamisso's "table-mountain," which, as he rightly divined, is of a similar nature from base to summit. All this is coral reef; how much more may be so it is impossible in the present state of our knowledge to say.

The general feeling of disappointment with which our failure to bore through the reef was received was fully shared by our friends in Sydney. Determined not to be put off with a first rebuff, they promptly commenced to make arrangements for a second attempt, and last year (1897) an expedition again left Sydney for Funafuti, this time under the direction of Professor Edgeworth David of the University of Sydney. Under his leadership the boring proved a complete success. The reef was penetrated to a depth of 697 feet, or 116 fathoms. Thus Darwin's wish has now been more than satisfied. The core

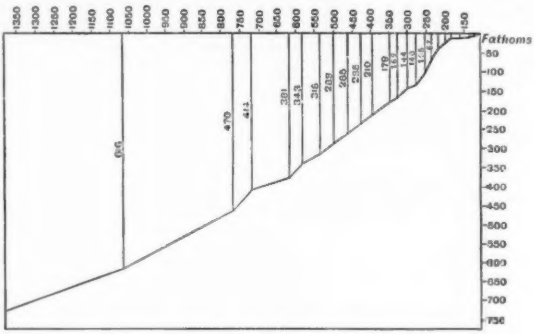

FIG. 13.

brought up was sent over to this country, and is now in the hands of Professor Judd for investigation. Till he has completed his report it would be premature to enter into details, but from a general examination, made without the aid of the microscope, I think I may fairly venture to say this much, that the material brought up from the boring, and of which the reef is composed, presents much the same general character throughout, and so far supports Darwin's theory; that layers of chalky ooze, such as on Sir John Murray's hypothesis we might have expected to find in the lower parts, are conspicuously absent; and finally that it presents no trace of volcanic material.

On whatever side judgment may ultimately be given in this question, the thanks of the scientific world must undoubtedly be conceded to Sir John Murray for having disturbed a decided opinion from its slumber, for having awakened a fresh interest in Darwin's theory, and in thus leading to renewed investigation, which is both adding to our knowledge and suggesting fresh inquiry.

The sand showing little trace of consolidation which was noticed in our boring down to 100 feet is maintained in Professor David's boring down to about 100 fathoms, and it is not a little remarkable that

material so loosely aggregated should be able to sustain itself in slopes of as much as 80°, such as characterise the flanks of Funafuti. It is important, however, to observe that none of the borings yet made have been sunk through the true growing substance of the atoll. They have commenced on the lagoon side of the true coral reef, and the deeper they have descended the more remote they have become from the ocean flanks. The possibility exists, and should not be overlooked, that a great part of the material passed through in the bore-holes represents deposits of the lagoon and of the fragmentary debris driven towards it by the breakers.

It will be observed that Professor David's bore-hole does not traverse the whole thickness of the table-mountain; judging from the soundings, it would have to descend 20 or 30 fathoms deeper to do this, and it would seem likely that the material obtained from this last 20 or 30 fathoms might surpass in interest all the rest. Our friends in Sydney fully appreciate this, and are so bent on probing this question to the utmost, that they have already despatched, at great pecuniary risk, an expedition to make a third attempt on Funafuti, and this time to carry the bore-hole right through the table-mountain.

The boring party is at this moment at work on the island, and before many weeks have elapsed we may expect to receive tidings of their success. A great stride will then have been taken towards a final determination of the long-standing controversy on the origin of atolls.[1]

We eagerly await the result, which will inform us whether these central oceanic islands are ancient remains of land which have plunged beneath the sea and are renewing their youth, or whether they are among the latest products of our planet, aspiring mountains which have scarcely yet succeeded in their struggle upward to the light of day; whether they are, as has been said, "a garland laid by the hand of Nature on the tomb of a sunken island," or whether they may not be a wreath of victory crowning a youthful summit on its first conquest of the main.

[1] The critical point has been passed. (See *Nat. Sci.* xiii. p. 362.) According to the news from Funafuti (Sept. 6) the boring attained a depth of 987 feet, or 147 feet below the base of the steepest cliff. The material passed through was coral limestone. It is of interest to observe that, soon after passing the bottom of Professor David's bore-hole, loose unconsolidated deposits ceased to be encountered, and the drill passed with comparative facility through a hard limestone containing numerous well-preserved corals. A crux of all theories of atolls is the lagoon. On Darwin's theory its explanation follows naturally from the fundamental assumption. Sir John Murray has to supplement his hypothesis by a separate explanation, and proposes to account for the lagoon by solution. In this connection the success which has attended an attempt of the present expedition to bore into the bed of the lagoon is most welcome. The boring was made from the deck of H.M.S. "Porpoise," commanded by Capt. Sturdee, and after passing through 101 feet of water sank 144 feet into the deposits of the floor. The first 80 feet were found to consist of the calcareous alga *Halimeda* mixed with shells; the remaining 64 feet of the same material, mingled with coral gravel. This alga is universally distributed over the floor of the lagoon, as proved by an examination of the material obtained by Capt. Field in sounding, and since it contains a certain percentage of magnesium carbonate we are led to expect that the formation of dolomite will be found to stand in some connection with the transformation of lagoon deposits.

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Professor Weldon's Evidence of the Operation of Natural Selection.

By J. T. Cunningham, M.A.

In his Presidential Address before Section D of the British Association, at its last meeting, Professor Weldon gave an account of his investigations of the variation of the shore crab in Plymouth Sound. The Address is printed in the number of *Nature* for September 22, 1898. The evidence it contains is considered by the author to prove, firstly, that a certain change has taken place in one character of the animals in question in the period of five years, and secondly, that the change has been caused by a selective destruction of individuals, due to the increasing turbidity of the water in which they live. These conclusions, if correct, would be of very great importance, and for this reason it is necessary to examine and consider carefully the evidence on which they are based. I have examined the evidence, and it does not seem to me to furnish the proof required. I propose to state here the reasons why I am unable to accept Professor Weldon's conclusions.

He gives, in the first place, three determinations of the mean frontal breadth of the crabs, expressed in terms of the carapace length taken as 1000. In other words, he measures the frontal breadths of individual crabs, and expresses them as so many thousandths of the length of the carapace. The three determinations are one for each of the years 1893, 1895, and 1898. It is important to observe that the mean frontal breadth in crabs collected at the same time varies very rapidly with the length of the carapace. The mean was therefore determined for every ·2 mm. of carapace length in crabs from 10 to 15 mm. long. The larger the crabs, the less is the mean relative frontal breadth. For example, in crabs 10·1 mm. long in 1893, it was 816 thousandths of the length; in crabs 14·9 mm. long, it was 751 thousandths—a decrease of 65, omitting decimal fractions.

For groups of the same carapace length the mean frontal breadth was less in 1895 than in 1893, and less in 1898 than in 1895, but the numbers measured in 1898 were admittedly very small. Here arises the first objection to the argument. The dimension was less in crabs of the same size, but every dimension observed in one year was

present in the other years, in crabs of a different size. The character investigated is in a state of transformation during growth. Crabs of a given size, say 12·1 mm., were narrower in 1895 than those of the same size in 1893, but crabs of 1895, a little smaller, had the same frontal breadth as those of 12·1 mm. in 1893. In other words, a given mean frontal breadth was never wanting in any of the three years, but was found associated with a different size of the crab. From this fact alone it is impossible to base any argument concerning selection on the variations observed and recorded in Professor Weldon's Address. The variations investigated are variations of the mean frontal breadth in proportion to carapace length, and it is not even suggested that any particular variations were absent, or less frequent, less common, in one year than another. It is merely stated, and may be accepted as a fact, that each degree of the dimension was found in smaller crabs in the later years. It does not matter whether we say that crabs of a given size were found to be narrower in frontal breadth, or that crabs of the same frontal breadth were found to be of smaller size. In consequence of the diminution of the frontal breadth with increase of size both statements are equally true.

Before proceeding to the explanation given of the cause of the change, it may be noticed that in a footnote a previous hypothesis put forward by Prof. Weldon concerning the selective destruction of variations in this character is now abandoned, and we are informed that it is to be replaced by the results contained in the Presidential Address. That previous hypothesis was that the narrowest as well as the broadest fronted crabs were killed off, so that the range of variation in the older and larger crabs was reduced. Of this previous conclusion a very eminent Darwinian said at the time, in a letter to *Nature*, that its demonstration "deserved to rank among the most remarkable achievements in connection with the theory of evolution." It is evident now that this admiration was premature; the process was hypothetical, had never been demonstrated at all, and the hypothesis is now abandoned in favour of a kind of selection which is quite inconsistent with that formerly suggested.

The measurements, to which I have referred above, all relate to male crabs; the change in females during the same time is said to be less in amount though in the same direction.

Prof. Weldon is confident that the change is due to a selective destruction caused by increase in the amount of sediment in Plymouth Sound. According to his argument the turbidity of the water in the Sound is increasing because the breakwater obstructs the scour of the tide and removal of the silt, while china clay is brought down by the rivers from Dartmoor, and the increasing population, dockyard, and shipping imply the passage of more sewage and refuse into the Sound.

In order to ascertain whether the broader fronted crabs were killed by sediment, a number of specimens were put into a large vessel of water in which fine china clay was placed and kept suspended by an

agitator. After various periods of time the dead crabs were separated from the living, and the mean frontal breadth of those that died was distinctly greater than that of the survivors.

A similar result was obtained when crabs were treated in the same way with fine mud obtained from the shore on which they were found. Professor Weldon concludes that the action of mud on the beach is the same as in the experiment, and that here we have a case of natural selection acting with great rapidity because of the rapidity with which the conditions of life are changing.

Lastly, there is another experiment in which some hundreds of crabs were kept, each in a separate bottle until it moulted, when of course it became larger. At first some crabs died and these were found to be those with broadest frontal regions. This was therefore a selective destruction without the influence of mud, and was proved by a separate experiment to be due to the putrefaction of the particles of food with which the crabs were fed. So that organic putrefaction and bacteria have the same effect on the crabs as inorganic sediment. The surviving crabs moulted, and after they had hardened their new shells they were killed and measured, and their dimensions compared with the dimensions they had before the moult, as ascertained from the cast shells. Before the moult the mean frontal breadth was below the normal for the size, afterwards it was above the normal for the new size, and some specimens were very remarkably broad. The reason for this is stated to be that the same crabs were measured at the two sizes, while in nature during the interval the broadest specimens had been killed off.

With regard to the experiments with china clay and mud, I would point out that the smallest and youngest crabs are the broadest fronted, and that the result might easily be explained on the hypothesis that the smallest and youngest crabs succumbed first. Professor Weldon believes that death occurs because a narrow frontal breadth renders the filtration of the water entering the branchial chamber more efficient. But filtration would depend on the absolute size of the apparatus, and this is getting larger as the crab grows larger; therefore the larger crabs ought to be killed first, and in nature all the adults ought to be killed. On the other hand, if relative frontal breadth has the importance supposed, the selective destruction ought to be greatest on the very young crabs, and if it kills the broadest fronted of those between 10 and 15 mm. long, it ought to kill all those under 10 mm. in length, since these are all broader. In this case there would be no crabs over 10 mm. in length.

In fact, Professor Weldon argues that selective destruction has in five years produced a diminution of not more than 18 units in the frontal breadth of crabs of the same size, while his observations show that there are living on the same shore at the same time multitudes of crabs of different sizes whose frontal breadths differ by

as much as 65 units. If we took into account crabs less than 10 mm. long and adults, the difference in their relative frontal breadths would be much more than 65 units. As a proof that the cause of death in the experiments with fine clay or mud was the entrance of the latter into the gill chamber, Professor Weldon states that the gills of the crabs which died were generally covered with the sediment, while those of the survivors were not. But the dead crabs were taken out at the end of the experiment, so that they had been in the muddy water some time after death, while the survivors were taken out alive. It is possible, therefore, that the sediment found its way in after death, and the evidence is no proof that filtration was more efficient in one case than in the other.

From Professor Weldon's own point of view the result of the moulting experiment does not bear the interpretation he puts upon it. He states that the crabs measured before the moult were on the average narrower than those on the shore. Therefore, immediately after the moult these same crabs would still have been narrower than their fellows on the shore which were of the same size before the moult, and moulted at the same time. Consider 500 crabs, say all 10 mm. in length, in the bottles, and 500 of the same size on the shore. The former have narrower frontal regions. Both undergo a moult at the same time; if there is no difference in the growth of the two groups the crabs in the bottles must be still narrower, for they are the same crabs in another stage. But those on the shore are exposed to selective destruction after the moult. This cannot well reduce the mean frontal breadth below that of those in the bottles, for it now has a narrower breadth to act upon, and in the previous stage it was not able to reduce the frontal breadth so low as that of those in the bottles. Of course I understand that after the moult some of those on the shore are supposed to be killed off, and none of those in the bottles. But the 500 on the shore were broader to start with by actual observation, and if they could survive with this greater breadth at the size before the moult, I fail to see why many should be killed off when they reach a larger size and a narrower relative frontal breadth. Moreover, there are, in fact, multitudes of crabs on the shore a little smaller than those in the bottles after the moult, and of the *same* mean frontal breadth.

It seems to me, as I suggested in a letter to *Nature*, that all Professor Weldon's observations may be completely explained by variations in the amount or rate of growth. The difference in different years would be at once explained if the amount of change in frontal breadth was constant for each moult, while the amount of growth was variable. The fact is, that in 1893 crabs of a given frontal breadth were larger than in 1895 and 1898; and I have shown that the summer of 1893 was exceptionally fine and warm. Either the warmth alone, or warmth and food together, very probably made the crabs grow more in that year for the same number of moults. On this view the broad-fronted crabs

died in the experiments with clay and mud because they were younger and weaker. In the same way the crabs that moulted in the bottles possibly grew more than those in the sea, because they were kept in warmer water and supplied with more food. Therefore they were, after the moult, larger than those in the sea of the same relative frontal breadth.

My suggestion is also in accordance with the fact stated by Professor Weldon that there was less change in female crabs than in male. If the difference of frontal breadth was the cause of selective destruction, it is difficult to see why it should act on one sex more than on the other. On the other hand, it is known that male crabs are larger when adult than females, therefore they grow faster, and their growth would be more affected by changes in the conditions of life in different years.

Professor Weldon states, in reply to my letter in *Nature*, that he has tested my suggestion and found that it is not in accordance with the facts. Apparently he has examined the measurements of the crabs which moulted in his experiment, and found that those which increased most in size at the moult did not differ in frontal breadth from the mean of those of the same size on the shore, more than those which grew least. According to Professor Weldon's original statement, the crabs that moulted were on the average broader than those of the same size on the shore. According to my suggestion, the broadest individuals should be those that grew most at the moult. This my opponent denies. I have asked him to produce the figures, but he declines to do so until all the figures relating to the matter are ready for publication.

As a proof that in the experiments with mud or clay the youngest crabs did not die first, he has instanced an experiment in which, out of many crabs 10 to 15 mm. long, only four survived, all under 13 mm. But he does not say that these four were the narrowest, as they ought to have been on his own hypothesis. If they were, they may also have been the oldest, or they may have been, if my second suggestion (see below) is correct, those which had grown fastest and were therefore the most vigorous. If they were not narrower than all the others which died, the experiment does not support Professor Weldon's conclusions.

Mr. Walter Garstang has challenged my suggestion in another way. In a letter to *Nature* he contends that exuviation is essentially connected with the process of growth in Crustacea, and that "in assuming similarity of size in young shore crabs to indicate an equal number of moults, Professor Weldon is quite in accord with our present knowledge of the subject." It would take up too much space to enter here upon a discussion of the question whether ecdysis is essentially related to increase in size or not, but I may refer to certain facts as to the relation between size and the number of moults.

In 1884 the late Mr. George Brook published a paper on the "Rate of Development of the Common Shore Crab" (*Ann. and Mag. Nat. Hist.* vol. xiv. pp. 202-207). He recorded a number of observations and measurements of young crabs kept alive for various periods in

captivity. Some of the specimens grew at nearly the same rate, that is to say, the increase in size was nearly the same after the same number of moults. But in other specimens this was not the case.

In August 1883 he obtained five specimens in the Megalopa stage. He gives the dates of the moults of two of these, and the sizes after each moult. These specimens he distinguishes as A and B. The latter, B, was later in moulting than A; its fifth moult (after it had attained to the crab-form) occurred on April 23, 1884, while A moulted for the fifth time on March 8. The crab, after the fifth moult, was in the case of B 5·7 mm. long, in the case of A 4·44 mm. long, a difference of 1·3 mm. In February both of these crabs had moulted four times, and there was a difference of ·34 mm. between them. This proves that crabs of different sizes on a given date in some cases have moulted the same number of times. Supposing the change in relative frontal breadth to be constant, or to be less variable than the increase in size, then these two crabs of different sizes would have nearly the same relative frontal breadth. To take another case from the same paper. A crab N was 12·5 mm. long in July 1882. After five moults, in the following May, ten months, it was 37 mm. long. Another crab Y was 12 mm. long in September 1882; after five moults, in the following June it was 45 mm. long, the moults having only occupied nine months. Here we have a difference of no less than 8 mm. in the carapace lengths of two crabs after the same number of moults, although their original difference was ·5 mm. In one case the increase was 24·5 mm., in the other 33 mm., a difference of 8·5 mm. in the increment. This shows how great may be the difference in the amount of growth after a given number of ecdyses. Supposing the larger crab did not cast its shell again for a month, we have the above difference of growth after not only the same number of moults, but after the same interval of time. If we look at the measurements recorded, we find that after four moults the crab Y was nearly of the same size as the crab N after five moults. Supposing then that the change in frontal breadth at each moult is nearly constant, is not proportional to the change in size, then the crab Y, though of the same size as N, was one moult behind it, and therefore of distinctly greater frontal breadth, since the relative frontal breadth decreases at each moult. Thus, if the crabs in 1893 in Plymouth Sound grew as much in a given moult as Y, while in 1895 they grew at the rate of N, then the crabs of the same size in the two years would represent different numbers of moults. Unfortunately Mr. Brook did not measure the frontal breadths, and therefore I cannot carry the argument further, but it seems to me extremely probable that the change in the frontal breadth of crabs which reached a given size in four moults, would not be the same as in those which reached it in five moults. If that is correct, all Professor Weldon's evidence proves is that the crabs grew more at each moult in 1893 than in 1895, and the evidence he has produced

has no bearing on natural selection at all. Of course I admit that some of the crabs in Mr. Brook's experiments grew nearly the same amount in the same number of moults, but the point is that others did not.

Another curious point brought out by Brook's records is that, when a given number of moults results in greater growth, the time occupied by those moults may be more or less than in the case when the growth was less. Thus, in the second of the above cases the larger crab took less time for the same number of moults than the smaller crab, in the former case the larger crab took longer time than the smaller for the same number of moults. It is evident that the relation of the growth of a crab to age and ecdysis is very complicated.

Professor Weldon has however informed me privately that he finds the abnormality of frontal breadth to be very nearly independent of the growth-rate during a moult, but that the difference, such as it is, shows that the crabs which grow most are on the whole very slightly narrower after their moult than those which grow least, in comparison with those of the same size in the sea. In consequence of this it has occurred to me that perhaps my first suggestion was wrong, and that the effect of conditions on growth is exactly opposite to that described above. It is certain that both the frontal breadth and the carapace length are growing, and that the carapace length grows faster, since the larger crab has an absolutely greater but relatively narrower frontal breadth. Now, if any circumstance such as temperature or food increases the growth, it may affect the carapace length more than it affects the frontal breadth. In that case the crab that grew most in one moult would be the narrowest. For example, suppose that a crab has a carapace length of 1000 units, and a frontal breadth of 800 units. Suppose that under ordinary circumstances in two moults the carapace length increases to 1050 and the frontal breadth to 820, then the crab is of course larger and relatively narrower. Now, suppose that the growth is so hastened that it reaches the same carapace length in one moult. The effect on the growth of the frontal breadth may not be so great, and thus this dimension may only increase in the one moult to 815; thus the crab of the same carapace length is narrower because it has grown twice as fast. Perhaps this view of the law of growth is more probable than the other.

But it will be said this new suggestion could not fit the same facts as the other. It would fit the same facts of observation, though of course the supposed conditions of life must be different. The conditions on this hypothesis were more favourable to growth in 1895 and 1898 than in 1893. In the experiment when the narrowest fronted crabs of those of the same size survived, it would have been because they were younger but more vigorous than those which had not grown so fast, the rapidity of growth being a sign not of weakness but of strength. In the moulting experiment the amount of growth would on this hypothesis be less than in crabs on the shore, and therefore the

crabs would be broader than those of the same size on the shore. Whatever the influences of conditions on growth may be, I feel convinced that the facts observed by Professor Weldon are due to such influence, and for the reasons I have given, not to selective destruction. I have shown that either of my two hypotheses would explain the facts better than the selective destruction which Professor Weldon believes to be the cause.

In 1895 Professor Weldon stated that his statistical results could not be considered to be established until the law of growth of the crabs had been experimentally investigated. Yet he now publishes with equal confidence quite different results from statistical data, although in the meantime he has produced no evidence whatever concerning the relation between variations of growth and change in the relative frontal breadth.

In reply to my letter in *Nature* Professor Weldon urged that, if my suggestions were correct, crabs gathered in January would be narrower in the frontal region than those of the same size gathered in August, and he had found that those gathered last January were not narrower than those gathered last August. But such a result does not follow from my view. According to Mr. Brook's experiments crabs above 10 mm. in length would be at least a year old, and therefore had been under the influence of all seasons of the year, and shore crabs hatch their eggs from February or March till late in summer. Therefore crabs taken in January have not necessarily grown under more unfavourable conditions. On the other hand, the observation of Professor Weldon that the crabs taken in January were not narrower than those taken in August shows that there had not been a continuous diminution in frontal breadth from August 1893 to August 1898, as he stated in his Address.

Whether either of my suggestions in explanation of the observed facts be correct or not, I think I have shown that the evidence on which Professor Weldon bases his conclusions is quite inadequate to establish them. The change described is not, if terms are used correctly, a change in the character of the species, but merely a change in the rate of development. The variations investigated are not individual differences, since each individual in the course of its growth passes through each one of the variations in its own person. It has not been shown that the change has gone on continuously for five years, or that it has taken place only in waters where there is much mud. If tadpoles of the same size were found to have shorter tails in one year than in another, few biologists would draw the conclusion that the result was due to the selective destruction of those with the longest tails. The more probable explanation would be that those with the shorter tails were in a more advanced stage of their metamorphosis.

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Biological Analogy and Speech-Development.

By Henry Cecil Wyld.

Professor Paul, in the chapter headed "Sprachspaltung" of his luminous book "Die Principien der Sprachgeschichte" (2te Aufl: Halle 1886), places on record his astonishment that students of the science of language do not oftener seek analogies for the phenomena of speech-development from the processes of development which obtain in organic nature. It is indeed to be lamented that philologists do not often make themselves familiar with biological method, and with the main results attained for evolutionary thought in this domain of science. For, indeed, did students of language possess an organised system of thought upon lines of evolution, as applied to speech, there can be small doubt that not only would linguistic science be placed upon a broader and more philosophic basis than it rests on at present, but from the nature of the field of inquiry evolutionary thought as a whole would receive a most suggestive contribution. It is indeed possible that many general questions, upon which at the present moment the minds of biologists are clouded with a doubt, would be set at rest one way or the other, and this or that theory of the modes of evolution would be either exploded or firmly established. For, whereas biologists have to trust to an imperfect geological record for a large part of their evidence, the philologist may observe in the course of five hundred years a change in language, much more significant and considerable than the same number of millenniums could effect upon species of animals or plants.

Professor Paul then ventures upon an analogy, and a fascinating one it is, between the factors and conditions which determine the evolution of species and those which govern change in language.

Unfortunately not only does this analogy share with others the fate of containing a fallacy, but the whole passage is, in my opinion, fraught with no small confusion of thought and phrase. His case is briefly this—

Development in animal life depends upon two main factors: first, the characters of the parents; second, the environment to which the organism is subjected after its birth. The results of these factors are: from the first (the hereditary group) similarity with the parents, and

therefore adherence to the general characters of the type; from the second, the possibility, within certain limits, of departure or divergence from the ancestral type.

With regard to speech, we find likewise two main factors of development: on the one hand, the speech of each individual is acquired from and moulded by the commerce of his associates, whom we are to consider as his linguistic parents as it were, while on the other hand, it is modified by his independent personal peculiarities and idiosyncrasies.

For speech, as for species, the former of these two factors, or groups of factors, is by far the more important, and that because every modification of the nature of the individual (speech or organism) which diverges from the originally *inherited* tendency, determines the direction of variation for the succeeding generation.

But we must not forget, says Professor Paul, that there are important differences between the conditions under which an animal on the one hand, and a language on the other, is born. For whereas the direct influence of the parents ceases for the animal from the moment of its birth; the speech-parents of an individual exert their influence from his first infant babblings down to the latest moment of his life, although in a varying degree.

Again, whereas the animal or plant has but two, sometimes only one parent, the speaking individual learns from hundreds of different speakers, and has therefore an almost infinite number of "strains" infused into his speech. This I believe to be an accurate statement of Professor Paul's suggestive comparison.

But if we examine it closely, and endeavour to use it as a starting-point from which to think out the process of speech-development, the analogy fails us at every turn, and appears, in fact, to lead us into one blind alley after another. In the first place, it is surely a confusion of terms to speak of an inherited character as a "factor" of development. It is rather a fact of life. The factors which may modify the inherited characters are left untouched and unnamed. If we were to say that an organism inherits tendencies to change in a certain direction, we might then, I conceive, talk of this inherited tendency as a "factor" in evolution or development; but Professor Paul seems to take for granted that all inherited characters make for a conservation of type, so that they are thus, strictly speaking, not factors of development at all. In passing, we may note that it is scarcely biologically conceivable that characters acquired in the lifetime of the individual, mere modifications of structure from the action of the environment, should form a starting-point for permanent variations in the species, or, as Professor Paul puts it, that "every modification of the nature of the individual which diverges from the originally inherited tendency determines the direction of variation for the succeeding generation." But we need not pause here to discuss the moot question of whether acquired characters are inherited, but may pass on to criticise the justness of the rest of

the above comparison between language and species. It appears that we are to consider the speakers from whom we learn our language as corresponding to the parents on the biological plane, and the speaker's own individual temperament of mind and body as corresponding to environment. Now, as a matter of fact, the great majority of speakers with whom we come in contact must, as regards their influence, be divided into at least two classes: the persons who, in the first place, teach us the beginnings of speech, and the persons who afterwards modify in one way or another the speech which we already possess. The first class are all those speakers who help to build up our mode of speech down to the moment when, so to speak, our speech crystallises and becomes characteristic of ourselves. This moment is, of course, an abstraction, but there comes a time in the life of each individual speaker when his habit of speech is to all intents and purposes formed, and after which he practically ceases to "learn." Until this happens, we may, if we choose, consider our associates as our speech-parents. This is, as it were, the period of gestation, and when it is over our independent life begins; independent, that is to say, just as far as any life can be independent of its environment. The associates of this second period of life, in which we are independent of parents, must be considered rather as part of the linguistic environment. Professor Paul's contention that the animal has only two parents is, of course, without weight, since the individual organism is the product, not of a single pair, but of millions of ancestors, any one of whom, remote or near, may assert his supremacy in the building up of his descendant. In this way the physical structure of an animal is the result of factors certainly no less numerous, complex, and varied than those which go to the making of a man's manner of speech.

It seems to me improper to drag the mental and physical constitution of the speaker into this analogy, because to do so is to go off into the domain of biology and psychology, and we are comparing linguistic facts with facts of organic life, and not these with themselves. But, it may be asked, are we to leave these facts altogether out of consideration as regards language and its development? The answer is, certainly not, and the whole difficulty arises from having made a false analogy at the outset. There is an unfortunate habit amongst students of language, of considering this as if it had an existence apart from the speakers. Professor Paul in his brilliant book has done more, perhaps, than any other philologist to break through this mode of thought, but he has apparently lapsed into it again in the chapter on "Sprachspaltung."

The safest way to think of language is as a habit of body expressing a habit of mind. Sounds, which are the external side of speech, are due to certain modes of movement of the vocal organs. Vocabulary, or system of nomenclature, is the association of sounds with emotions and ideas. Grammar, a further mental process, is the expression of

the perceived relations of emotions and ideas with other emotions and ideas. The very articulation of sounds, as Professor Paul admirably and clearly points out, is due to certain psychological processes. Thus each division of language depends upon mental states, and the sounds themselves which body these forth are the direct results of organic movements. It becomes clear then that speech, like other habits, and perhaps in a more subtle and complex manner than any other habit, is learnt in the beginning by imitation, and is modified and moulded by each individual in the mint of his mental and bodily personality. According to this view, therefore, the factor which makes for conservation of speech type is the necessity for intelligibility: that which makes for variation is divergency of temperament, psychological and physiological, among the speakers. But although the dominating function of these two factors is respectively change, and a hindering of change, they each contain the potentialities of the converse. For, since there is undoubtedly an objective tendency on the part of a community as a whole to slowly change their speech in the same direction, it is clear that a wilful conservatism on the part of the individual would defeat his object of being intelligible to his fellows. So, again, the tendency of the individual to vary in habits of body and mind will have a limit set to it by conditions of life, of climate, of race, of education, of ideals, and of morals, which he will undergo in common with the other members of the society to which he and they belong.

It is these cross currents of tendency which complicate the whole problem of the evolution of speech, and make it difficult to state the question with clearness and completeness. Still, these difficulties must some day be met, and it cannot be denied that so far nobody has made an adequate attempt to meet them. It were devoutly to be wished that some scholar of sufficient courage and learning would rend the veil, and light up the darkness beyond. The archives of the Science of Language are at this moment like a magnificent collection of stuffed animals and carefully-preserved beetles, most of them indeed roughly classified and ticketed. We contemplate them with no little enthusiasm, we have numbered the hairs on the heads of many of the larger mammals, have gathered the dust from the wings of the butterflies; but if you ask us whence they came, or question us as to their life, their growth, and death, we cannot tell. Like the learned ancients who beheld the flies in amber, "we wonder how the devil they got there"; in fact, our philosophy of origins is that of Topsy. In the meantime philologists must watch and pray for the coming of their Darwin and their Weismann.

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Animal Symmetry.

By A. T. Masterman, B.A., D.Sc., F.R.S.E.

The least attention to the subject of the symmetry of organisms will serve to convince one that the present state of our knowledge, or, to speak more accurately, our present method of expressing the facts, is far from satisfactory. In most modern text-books professing to deal with animal morphology the subject is either left severely alone or is dismissed with a few remarks upon so-called "radial" and "bilateral" symmetry, illustrated by one or two well-known examples. Thus Hatschek [1] divides the Metazoa into Protaxonia and Heteraxonia, relying mainly upon the position of the blastopore; and if we go further back we find that the heterogeneous group Radiata owed its name to the emphasis of a particular prevalent form of symmetry.[2] Standard works upon botany devote more attention to this branch of morphology, as must needs be the case when the structure of flowering-plants is described.

As to a correct definition of the term "symmetry," when applied to organisms, there appears to be a considerable divergence of opinion. Thus, many botanists regard the symmetry of a flower as meaning the similarity of its constituent parts about one or more axes or planes, the term polysymmetrical being, from this point of view, regarded as equivalent to "actinomorphic," or, in other words, symmetry about a median axis, whereas "zygomorphic" implies a symmetry about a plane. Sachs draws distinctions between monosymmetry and polysymmetry on the one hand, and between bilateral and multilateral symmetry on the other, pointing out that the former are special cases of the latter. His term "monosymmetrical" alone corresponds to bilateral symmetry as usually accepted amongst zoologists. Geddes, in his suggestive article on "Morphology,"[3] remarks in this connection that "botanists since Schleiden" have contented "themselves with throwing organisms into three groups—first, absolute or regular; second, regular and radiate; third, symmetrical bilaterally or zygomorphic. . . . Burmeister, and more fully Bronn, introduced the fundamental improvement of

[1] "Lehrbuch der Zoologie."
[2] Cuvier, "Règne animal."
[3] Geddes, P., "Encyclopaedia Britannica," 1885, p. 843.

defining the mathematical forms they sought not by the surfaces but by axes and their poles."

By certain French and English botanists the terms "symmetry," "symmetrical," and "asymmetrical" have been employed in a very different connection, namely, to express the numerical correspondence or otherwise between the constituent elements of concentric whorls.

A definition which would include all these ideas would have to express merely a vague order of some kind, involving repetition, as existing between the parts of an organ or organism.

The term is used commonly amongst zoologists in a sense resembling the wider usage amongst botanists. Thus the acknowledged distinction of radially and bilaterally symmetrical organisms rests upon this interpretation of the term symmetry. But the so-called "zonal symmetry" instituted a fresh conception of the term "symmetry," which, if accepted, would again require a vague definition. In the former case we deal with the definite arrangement of the parts of an organism about a median geometrical centre; in the latter is introduced the idea of a serial repetition of certain parts along an axis, thus leading to a confusion between the terms "segmentation" and "symmetry." Haeckel[1] has recognised this distinction by applying the term "antimere" to the unit of so-called "radial" symmetry, and "metamere" to the segment or "zoonite."

Geddes[2] clearly shows how the study of symmetry implies the attempt to force mathematical or mechanical conceptions upon the organic world, and indicates that the attempts of Moseley and Goodsir in this direction were based upon many analogies which, "savouring more of the *Naturphilosophie* than of sober mathematics, could only serve to discourage further inquiry and interest."

The analogy drawn from time to time between the organism and a crystal and the parallel between Haeckel's "promorphology" and crystallography have an underlying basis of truth, but they are liable to be misconstrued if carried too far. The material basis of vital phenomena, namely protoplasm, is essentially amorphous (or truly asymmetric, see later) as regards any properties inherent in itself; and the form assumed by any mass of it, constituting for the time being an individual, must depend entirely upon the particular environment at that time. In highly differentiated individuals the exact extent of the direct effect of environmental changes is a disputed question, but by whatever particular path the process may be effected it may be taken as a truism that an organism tends to change its form in relation to changes of environment, and that while in the lower types the change is effected many times in the history of the individual, in the higher types it is with equal certainty effected in the history of the species. These considerations do not apply to the crystal.

On the other hand, the crystal and the organism are each isolated

[1] Haeckel, "Generelle Morphologie," Berlin, 1866. [2] *Loc. cit.*

masses of matter, and hence have similar stereometric relationships. Here the analogy ends.

Haeckel's classification of animal symmetry has not received the amount of recognition it deserves from zoologists, partly because it is encumbered with a copious and somewhat unwieldy nomenclature. Jaeger's text-book of zoology may be noted as one of the very few which give anything like an adequate discussion of the subject.

The other classic work dealing with the subject is Spencer's "Principles of Biology" (vol. ii. chaps. vi. and xiv.), which appeared at about the same time as Haeckel's work. It is difficult to understand why his classification of symmetry has not been more widely adopted, though it is regrettable that a classification equally applicable to both plants and animals, if anything rather more to the latter, should be more or less hidden in a chapter on the *Morphological Differentiation of Plants.* His classification, differing little from that proposed below, is followed by a characteristic attempt to show the inter-relation between the symmetry of an organism and its environment. Though written over thirty years ago, there is scarcely a sentence that does not apply with equal force at the present time. His three types of spherical, radial, and bilateral symmetry are equivalent to the centro-symmetry, axo-symmetry, and plano-symmetry, the first three types instituted below. The justification for alteration in the nomenclature will be there stated.

Amongst smaller works we may mention the essays of Dr. Amans,[1] dealing with the form of animals exhibiting aquatic locomotion. He follows up the "ovoid" form from the sphere through circular, elliptical, unisymmetrical, and asymmetrical ovoids, the bilaterally symmetrical ovoid being correlated with the highest form of locomotion. He thus recognises the great importance, previously pointed out by Spencer, of the form of locomotion in determining the form of symmetry.

Haeckel, twenty years after his former work (in 1887), returned to the question of animal symmetry in his "Radiolaria."[2] He points out that text-books such as those of Claus and Sachs give an insufficient treatment of the subject, and whilst recognising the difficulty of the nomenclature, he adheres to the principles formerly stated. He here gives four principal types of ground-forms which correspond to those of Spencer; and the first three are very nearly equivalent to the three types proposed below, with centres composed of a point, a straight line, and a plane respectively. His main subdivisions, the Homaxonia and Polyaxonia in the first group, and Monaxonia and Stauraxonia in the second group, do not appear to me to differ sufficiently in kind nor in degree to warrant the subdivisions,

[1] *Comptes Rendus*, cv. 1887, and *Ann. Sci. Nat.* vi.
[2] Challenger Report, vol. xviii.

as the sphere and the circle are usually treated geometrically as a polyhedron and a polygon respectively, but with an infinite number of bounding sides. Other differences will be noticed by a detailed comparison.

In comparing the various meanings attached to the term "symmetry" the only really consistent definition must be somewhat as follows:—Symmetry of an organism is the *system of arrangement of its constituent parts in relation to each other and to a certain geometrical centre, which may be called the centre or nucleus of symmetry.*

Animal symmetry is therefore merely a particular character of form, and as such it must be in the same direct relation to environment as any other morphological character. In order to illustrate this relation to its greatest extent one must adopt a classification of symmetry which will bear direct comparison with the different grades of environment. Only in so far as it enables us to correlate form and environment can a classification be regarded as "natural," just as a classification of species can be regarded as "natural" only when it expresses the true history of the changes of correlated form and environment, or the course of evolution, in the genus or family.

Our conceptions of space being based upon the three dimensions, we naturally turn to the geometrical conceptions and their classification in order to find a "natural" classification. In the inter-relation of organism and environment and its determining influence, we find that the three dimensional axes correspond to the lines of development, and hence they are never inclined to each other. In other words, we find no true "clinometric" forms, and we have only to deal with the "orthometric." The stereometrical representatives of the types will, therefore, all belong to the "right" series, and to this extent there is a marked difference from the types of crystallography.

Scattered throughout modern zoological literature we may find statements that "radial" symmetry is correlated with or induced by a sedentary or pelagic habitat, and others to the contrary, the latter mainly relying upon the fact that there are, at the present state of evolution, some sedentary or drifting organisms which show little if any "radial" symmetry. It should not be necessary to furnish proof that the symmetry of an organism tends to conform to the symmetry of environment. Assuming this statement, it is necessary to seek for a classification of environmental as a preliminary to that of organismal symmetry.

The widest division of symmetry of environment must depend upon the three dimensions, and this consideration leads us to the following divisions of animal form:—

1. *Centro-symmetry.*—This consists essentially of repetition of parts in three dimensions, hence the centre of symmetry is a point, the point of intersection of the three dimensional axes (Fig. 1). The minimum number of secondary centres of symmetry will be four, and the

predominant number will be six, corresponding to twice the number of dimensions. The geometrical representatives of these two conditions are the tetrahedron and the octahedron respectively, and the other possible numbers are represented by the cube, dodecahedron, and the icosahedron. An absence of secondary centres results in the sphere, hence the term "spherical symmetry," as used by Spencer. All truly centro-symmetric organisms should conform to the types of the regular polyhedron or the sphere, but are not necessarily confined to the latter. This type agrees also with the centro-stigma or sphaerotypic group of Haeckel.

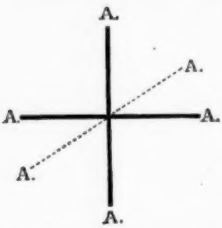

FIG. 1.—Centro-symmetry. (6 A.)

The organisms exhibiting this form of symmetry consist of a great number of Protozoa, such as the Heliozoa, and a large proportion of the Radiolaria and Reticularia. In addition to these, we may include certain of the Flagellata, as *Uroglena, Syncrypta* and *Pandorina*, and Acinetaria. A great number of the Protozoa also assume this form of symmetry as a transitory phase in their life-history (encystment). Apart from adult organisms, the great majority of the eggs of higher types conform more or less closely to this type, as also do the so-called blastula larva of the Metazoa, and the gemmules of Porifera, *e.g. Spongilla.*

We thus notice that the animal organisms which exhibit centro-symmetry are confined to the adult phases of the Protozoa and to the early ontogenetic phases of many higher Metazoa. It is evident that, with the form and constitution of the earth as it is at present, it is impossible to conceive of an environment in itself which is centro-symmetric, that is, symmetrical round a point. The fact that organisms dwell upon the surface of a sphere (oblate spheroid, to be more accurate), causes a constant heterogeneity in one dimension which, through the physical factors of gravity, and in most cases light, will be a constant factor in the induction of a certain amount of heterogeneity in organisms. Hence, in the attempt to correlate structure and environment, the existence of centro-symmetric organisms would appear to be a difficulty. This, however, is only apparent, for the effect of environment upon the organism is dependent not only upon the environment, but upon the manner in which the organism, so to speak, allows itself to be subjected to it. Thus Spencer points out that centro-symmetric organisms are usually free to rotate about their centre, either actively or passively, thus eliminating the effect of axo-symmetry in the environment.

Again, if the organism be for a time removed from the influence of its environment by the formation of a coat, a cyst, or a shell, the influence being reduced to zero in all directions, the centro-symmetric form will be assumed.

Thus we may connect the occurrence and origin of centro-symmetry in organisms with two special conditions of existence:—Firstly, the free rotation, active or passive, of an organism about a central point; secondly, the free encysted or encased condition in which the living matter is more or less removed from the influence of its environment. The spherical form implies homogeneity, whereas the polyhedral types imply heterogeneity, as limited by certain definite numbers of secondary centres of symmetry.

Haeckel, taking the geometrical types of the sphere and the regular polyhedra as enumerated above, shows how each type is represented by certain of the Radiolaria. A similar classification could probably be effected in each group of the Protozoa, though perhaps not quite so completely.

The experiments of Quincke, Bütschli, and others with emulsion "foams," and of Roux with oil-drops, tend to emphasise the great importance of the physical environment in determining the morphology of the asymmetric and centro-symmetric Protozoa, and the early ontogenetic stages of Metazoa respectively.

2. *Axo-symmetry.*—This consists essentially of repetition of parts in two dimensions, and hence the centre of symmetry is formed by the third dimension, which is the axis of symmetry.

The minimum number of secondary centres of symmetry is reduced to three, and the dominant number will be four, corresponding to twice the number of the like dimensions. Above this the number is practically unlimited, as represented geometrically, from an equilateral triangle and a square through any regular polygon to the circle.

This type of symmetry is called "radial" by Spencer, but the term has been applied generally to include both this type and the preceding, as according to the meaning it might. On the other hand, if "spherical" symmetry is retained for the preceding, the equivalent term for "axo-symmetry" would be "circular symmetry." Haeckel classed this type with the next as Protaxonia, whilst Hatschek limits this term to the present type. Haeckel's later term is Centraxonia. Haeckel's types do not exactly correspond to axo-symmetry, for he includes those forms in which the two transverse axes differ from each other, whilst these are here included in the Plano-symmetric.

There are two conceivable types of axo-symmetry, namely, true or mon-axo-symmetry, and di-axo-symmetry (see Figs. 2 and 3).

In true axo-symmetry there is heterogeneity between the two poles of the dimension of symmetry; in di-axo-symmetry they are homogeneous.

True axo-symmetry is geometrically represented by a right regular pyramid and cone, di-polar by a right regular prism and cylinder.

The di-axo-symmetry is a rare phenomenon, mainly because axo-symmetric animals have their dimensional axis perpendicular, and hence this axis is subjected to the perpetual heterogeneity of environ-

ment already referred to. The conditions for the acquirement of di-axo-symmetry are a horizontal position of the main axis of the organism with free rotation about this axis. Certain Radiolaria, such as the Acantharia, according to Haeckel, present this ground-form, and the Amphistomina, certain of the Ciliata, and to some extent the Thaliacea, may serve as further examples.

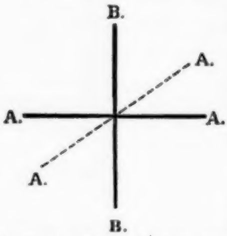

FIG. 2.—Di-axo-symmetry. (4 A + 2 B.)

True axo-symmetry is exhibited by a great number of animals, besides nearly all the plant kingdom. It is found in many of the Protozoa. It is the fundamental type of all the Porifera, Coelentera, and Echinoderma. Traces of it are found in the Polyzoa, Cirripedia, sedentary Annelida, and Tunicata. The Cuvierian group of Radiata depended mainly for its institution upon the presence of this type of symmetry. We have only to add that, in the ontogeny of many of the above, and in that of higher Metazoa, this type is represented by the gastrula.

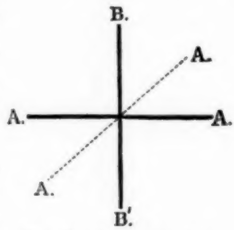

FIG. 3.—Axo-symmetry. (4 A + B + B'.)

A study of the above phyla will show that this axo-symmetry occurs in precisely the environmental conditions in which, from a theoretical point of view, we should expect to find it. They fall into three groups:—

1. Sedentary.
2. Pelagic floating (plankton in restricted sense).
3. Free pelagic with axial rotation.

(1) *Sedentary.*—It is usually granted that axo-symmetry is correlated with a sedentary existence. This statement is in no way invalidated by the instances of Cirripedia and others in which a very evident bilateral symmetry is still in evidence. That the "cirri" of *Balanus* tend to present an axial arrangement is readily seen by an examination of the living animal from above; and that the shells and, again, the stalk of *Lepas* are axo-symmetric in their arrangement is evident.

The modification from one type of symmetry to another will be proportional in completeness to the time during which the new environment has been effective, and, in addition, to the degree of differentiation to which the organism has already attained. Thus, *Amoeba* will adapt its form almost immediately to a change of environment, a Coelenterate more slowly, and a Cirripede more slowly still.

If an axis be drawn from the point of fixation of a sedentary organism at right angles to the plane of fixation, the environment on all sides of this axis will be similar (except in special cases, *e.g.*

currents of the medium) whilst the two ends of the axis will have dissimilar environments. This axis corresponds to the axis of symmetry of the axo-symmetric animals which are sedentary.

(2) *Pelagic plankton.*—If a perpendicular axis be drawn downwards from the surface of the medium of flotation, the environment on all sides of this axis will be similar whereas its two ends will be very dissimilar. Hence a floating (drifting) organism will have an axis parallel to the above and with similar properties. According to the principles of correlation, we find that the drifting plankton (Medusae, *Arcella*, *Pyrosoma*, etc.) are axo-symmetric about an axis which is at right angles to the surface. It may be noted that movement along this axis, *i.e.* the axis of symmetry, does not in any way affect the conditions of symmetry (Medusae, Ctenophora). It is quite irrelevant to the argument that Medusae may be descended from sedentary forms. They are axo-symmetric and pelagic drifters, agreeing thereby with an enormous number of other forms.

(3) *Free-swimming with axial rotation.*—If an organism move in one definite direction there is an evident dissimilarity in environmental conditions between the two terminal points of the axis of direction. If this direction correspond with the axis perpendicular to the surface it does not affect the axo-symmetry, for it only accentuates a dissimilarity which already existed, but if it be at any angle to the perpendicular there will be produced two axes of dissimilarity, and unless other factors intervene an axo-symmetric organism will be out of harmony with such conditions. If, however, the organism rotates about its axis of locomotion, the dissimilarity due to the physical conditions will be nullified, and the parts on all sides of the axis of direction will, in response to the similar environment, tend to become symmetrical, so that the axis of locomotive direction will be converted into the axis of symmetry and the organism will become axially symmetric.

Those who have observed the locomotion of gastrula-larvae speak of a spiral motion due to a movement forward along the main axis, combined with a rotation about the same. It is also quite possible that in many of the more active members of the pelagic plankton, in which the locomotion often brings the axis of symmetry at an angle with the perpendicular to the surface, a free capacity for axial rotation tends to perpetuate the axial symmetry.

In brief, the axo-symmetric organisms occur principally in the Protozoa, Porifera, Coelentera, and Echinoderma, and they are typically pelagic drifters, sedentary forms, or free-swimmers which rotate about the axis of locomotion, all of which habitats correspond to the theoretical conditions. In a great number of the axo-symmetric Coelentera there are two phases in the life-history (medusoid and hydroid) corresponding to the two principal conditions of existence in this type of symmetry, *i.e.* drifting and sedentary.

3. *Plano-symmetry* (Heteraxonia of some morphologists).—This

type, corresponding almost exactly with the "bilateral symmetry," is repetition of parts in only one dimension, so that the centre of symmetry is a plane formed by the two remaining dimensional axes. In this case the minimum number of secondary centres of symmetry is reduced to two, and, as there is but one dimension of symmetry, this corresponds to the predominating number.

Plano-symmetry occurs in a few of the Protozoa and Coelentera, and is found almost universally in the Metazoa above the Coelentera, though it may be more or less disguised in certain groups (*e.g.* Echinoderma, Tunicata), by a secondary superposed axo-symmetry. The environmental conditions for the production of this form of symmetry are not many. A primary physical environment fulfilling the desired conditions is not common nor easy of attainment. Locomotion of the organism in a definite direction, but forming some angle with the perpendicular to the surface or to the bottom, will supply the requisite dissimilarities of environment in two dimensions, provided that rotation about the locomotive axis be prevented. In other words, the motion is limited to one dimension, which, for the greatest effect, should be horizontal. Nevertheless, although this is the prevalent origin of plano-symmetry, a physical environment of an organism at rest is conceivable in which the necessary conditions are fulfilled. Thus fixation at one end will cause, as already shown, axo-symmetry if the axis is parallel with the perpendicular to the plane of fixation, but if they intersect at an angle, a factor of dissimilarity is produced, which, like the last, will be more potent the greater the angle. Examples of this type without locomotion in one direction are rare, but are probably exemplified in *Taenia*, *Loxosoma*, etc. In some text-books it is stated that "bilateral" symmetry is confined to animals with locomotion in one direction, but, as pointed out here, the necessary conditions are attained in a sedentary habit.

There are three possible sub-types of plano-symmetry, which are defined according to the heterogeneity in the dimensional axes. The first or tri-plano-symmetry (Fig. 4) has all three axes formed of similar component radii; and hence three planes of symmetry are present, intersecting each axis respectively. The geometrical expression of this type is the right rhombic prism or octahedron. It is included by Haeckel in a sub-group of his Centraxonia. Di-plano-symmetry (Fig. 5) has two planes of symmetry, as the radii of one axis differ. It is represented by the right rhombic pyramid. Plano-symmetry (or monoplano-symmetry) has only one plane of symmetry (Fig. 6) as the radii of two axes differ, and hence the plane of symmetry must pass through these two. It is represented by the right pyramid with a rhomboidal base. Spencer distinguishes these three as single, double, and triple bilateral symmetry (Figs. 4, 5, and 6).

The true plano-symmetry is by far the commonest, though instances of the others can be easily found. The typical Hexactinia, taking into

account the siphonoglyphs and mesenterial muscles, give a good example of di-plano-symmetry, whilst tri-plano-symmetry is found in certain Acantharia (Haeckel), and more or less perfectly in some of the Ctenophora.

There are several points to notice with regard to these three types of symmetry. These bear out our argument that they represent a natural classification.

Firstly, it has been already shown that a great number of the organisms which in other respects take their position at the bottom of

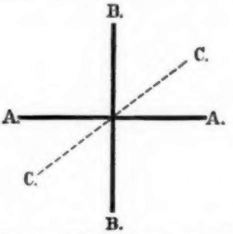

Fig. 4.—Tri-plano-symmetry. (2A + 2B + 2C.)

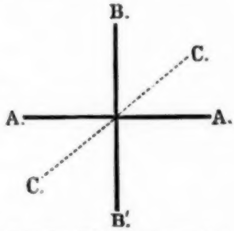

Fig. 5.—Di-plano-symmetry. (2A + B + B′ + 2C.)

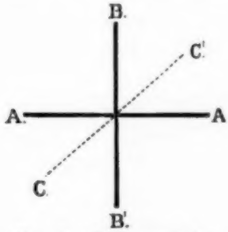

Fig. 6.—Plano-symmetry. (2A + B + B′ + C + C′.)

the animal scale belong either to no type of symmetry whatever or exhibit at one stage of their career a centro-symmetry (see Fig. 9).

Again, others of the Protozoa and almost all of the Coelentera, together with other groups showing degeneration, exhibit the second or axo-symmetry ; and lastly, the great majority of the Metazoa exhibit the third or plano-symmetry more and more markedly as the highest types are reached.

This classification, therefore, clearly indicates the phyletic progress in course of time from forms with no symmetry and ever-changing shape, through symmetry in all dimensions, to that in two, and finally, the successive types of symmetry.

In this connection we may look at the increasing influence of locomotion in the determination of an animal's symmetry. The locomotion in centro-symmetric forms is quite indefinite, with freedom to rotate about the centre and nothing more. That of axo-symmetric forms is in a definite direction in a considerable number, but may be in many cases entirely absent (sedentary). At most it is definite in only one dimension. In plano-symmetric forms the vast majority have definite locomotion, with a definite direction, in two dimensions. The gradual development of symmetry from a lower to a higher type is therefore in agreement with the general facts of evolution (see Fig. 7). Similarly in ontogeny the same history is recapitulated. With exceptions mainly traceable to secondary coenogenetic modifications, the ontogeny of a plano-symmetric organism commences with the centro-symmetric egg, which in the most primitive forms retains its centro-symmetry up to the free swimming centro-symmetric blastula-larva. The

presence of yolk may, in certain cases, enable the embryo to, as it were, take a short cut to axo-symmetry (unequal segmentation), otherwise the blastula in due course becomes the gastrula, a typical axo-symmetric organism, with locomotion in one direction and rotation about the axis so defined. Whilst the lower forms (Coelentera) remain at this stage, the higher pass on to the type of plano-symmetry, and thus the phyletic history is repeated (Fig. 7).

Reference has been made above to the secondary centres of symmetry and the predominant number of these in the three types of symmetry was stated to be six, four, and two respectively. Any organs in an organism must be centric or peripheral. If they are in the former

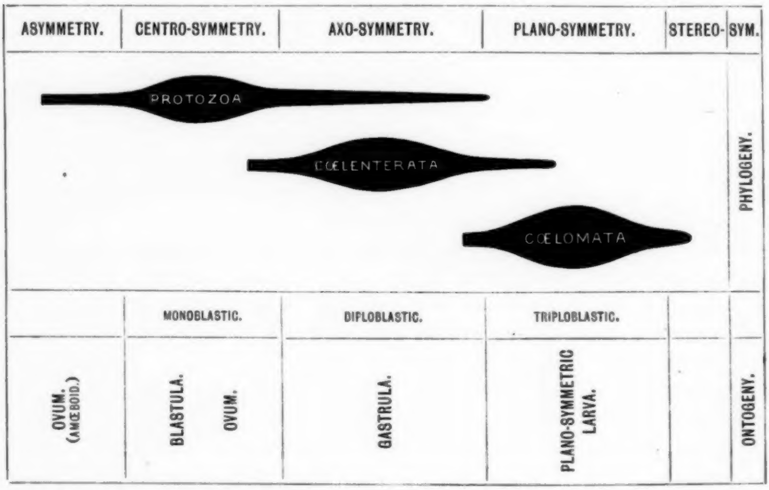

FIG. 7.—Diagram to indicate the relative predominance of each main type of symmetry in the chief divisions of the animal kingdom, and the gradual advance of type both in phylogeny and ontogeny.

category and conform to the symmetry of the organism, they must be single, and must be conformable to the centre of symmetry, whether a point, an axis, or a plane. If they are peripheral they must, in order to conform to the symmetry of the whole organism, be repeated a certain number of times round secondary centres of symmetry, and the primary numbers corresponding in each case to twice the number of symmetrical dimensions, work out as six, four, and two.

This subject is intimately connected with the theory of "metameric segmentation" and its attendant phenomenon and will be more fully dealt with later.

4. *Stereo-Symmetry.*—We have discussed in turn the three forms of symmetry, and the question remains—Is there not yet another? Our definition of the symmetry of an organism reads as follows:—The system of arrangement of its constituent parts in relation to each other and to a

certain geometrical centre. In the former three systems the units were arranged with respect to (1) a point, (2) a straight line, (3) a plane. Each of these two last geometrical expressions is formed by the motion of the former, thus conferring upon the centre of symmetry an additional dimension, and lastly, the motion of the third centre of symmetry, or the plane, results in a centre of symmetry of three dimensions. In the same way, in centro-symmetry we found that organs with secondary centres were repeated in three dimensions (6), those in axo-symmetry in two dimensions (4), and those in plano-symmetry were repeated in one dimension (2). Similarly in this last type (stereo-symmetry), as the centre of symmetry is tri-dimensional, the organs will not be repeated at all (Fig. 8). This is evidently an entirely different condition from asymmetry, in which there is no "system of arrangement of the parts" found in the amorphic Protozoa and others (Fig. 9).

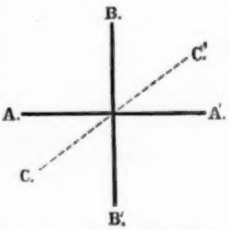

FIG. 8.—Stereo-symmetry. (A + A′ + B + B′ + C + C′.)

In the first three forms of symmetry one can notice how the organism, by its gradual differentiation, becomes as it were the determining factor in its relations to the environment. Thus it is mainly the mode of locomotion which is adopted (or the introduction of voluntary movement) that results in the production of a plano-symmetric organism, and in a precisely analogous manner in stereo-symmetry the organism becomes more independent and predominant over its own fate in determining the way in which its environment shall affect it.

The gradual evolution in the animal kingdom results in a graduated succession of organisms becoming more and more independent of their environment, in so far as that environment has power to mould the organismal form into harmony with itself.

In the preceding cases the organisms exhibiting those types of symmetry are to that extent in equilibrium with the same type of environment, and in asymmetry the organism rapidly changes its form to adapt itself to a change of environment, but in a stereo-symmetric form the organism has so far brought itself to be partially equilibrated to any change of environment without actual change in general form on its own part, that it may be said practically to have released itself from its environmental thraldom, as far as symmetry is concerned. Hence its organs will never be repeated in cases where the pair are not absolutely inter-dependent (*e.g.* the paired eyes), and the form of the organism will be determined solely by the inter-relations of its parts. This ideal is not as yet reached in the animal kingdom, for all the plano-symmetric animals still show marked traces of their "paired" condition. On the other hand, stereo-symmetry is continually being evolved in them by a division of labour between the two "paired" elements, so that in the highest types the "bilateral" or paired arrangement is to some extent effaced.

Perhaps the most recent example of this type, in the highest of animals, is the universal tendency to right or left-handedness in man.

This fourth type of symmetry must be carefully distinguished from the cases of peculiar arrangement of parts due to the superposition of one type of symmetry upon another, or even of one type upon itself but in a different relation to the organism. Thus, in the majority of the Echinoderma the "plane" type has probably been impressed upon the "axial" of the Coelentera, only to be in its turn "covered" by the axial type of the sedentary period. Lastly, some species, such as *Spatangus*, have early traces of a "plane" type again superposed upon the "axial," and a further reversion to the "axial" is found in *Pelagothuria*. Again, in the Pleuronectidæ the so-called asymmetry is evidently due to a second plano-symmetry superposed upon the first, with the two planes of symmetry perpendicular to each other. In all these cases the transition will involve an apparent asymmetry or stereo-symmetry.

The four types of symmetry and their sub-types may be shown diagrammatically as in Figs. 1-6, and Fig. 8, in which each of the three dimensional axes is indicated, and their resemblances or differences are shown by letters. The increasing heterogeneity as the various types are passed through is shown clearly by the formulae below the figures. Again, if a regular tetrahedron be taken instead of an octagon, because it is the simplest possible solid figure, then the four main types of symmetry are indicated as in Figs. 9-12, whilst in this case the sub-types can only be shown by a reference to the planes of symmetry of a tetrahedron, into which it is not necessary to enter.

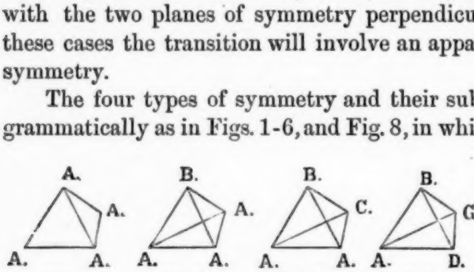

Fig. 9. Fig. 10. Fig. 11. Fig. 12.

Fig. 9.—Centro-symmetry. (4A.)
Fig. 10.—Axo-symmetry. (3A + B.)
Fig. 11.—Plano-symmetry. (2A + B + C.)
Fig. 12.—Stereo-symmetry. (A + B + C + D.)

The term "asymmetry" should be strictly confined to the absence of all definite "arrangement," and in this sense it has been used by Spencer.

The "asymmetry" of the chemists and physicists is, however, exactly analogous to stereo-symmetry as here defined, and both phenomena are alike due to the highest possible "arrangement" of the mass in each case. Pasteur's conclusions with regard to the intimate connection of molecular stereo-symmetry and organic phenomena have been recently brought forward with renewed emphasis by Professor Japp.[1] The ascertained fact that the molecular stereo-symmetry is a characteristic feature of "organised" matter, pointed out by him, is interesting in view of the fact that the evolution of symmetry in the animal kingdom indicates a gradual transference of stereo-symmetry from the molecule

[1] President's Address, Chemical Section, British Association, Bristol 1898.

to the entire individual, although the latter end of the series has not yet been completely attained. There is also this parallel, that in the formation of the stereo-symmetric individual only one " form " is evolved, just as occurs in vital molecular phenomena in contradistinction to purely chemical.

Thus we do not find any human body with a liver on the left side, with stomach and spleen on the right, a right aortic arch and a left azygos vein, and so on, though it would be hard for an anatomist to pronounce that such an enantiomorph of the human subject is an impossibility, and harder still to say why such is not in existence.

Could an experimental morphologist immensely hasten the processes of evolution there should be no difficulty in subjecting any given organism to a special environment, and, by the inter-action of the two, producing an organism exhibiting any of the three types of centro-, axo- or plano-symmetry. By having recourse to a special environment (separation of the blastomeres) he may even to some extent produce stereo-symmetric organisms, but in equal quantities of right and left-sided individuals, unless one enantiomorph is destroyed purposely in the making. By no process could he produce a single stereo-symmetric " form " without its enantiomorph, because the origin of such lies in the molecular constitution of the organism and has no connection with the environment.

Though not expressed in chemical language, the analogy of the above to molecular stereo-symmetry is complete.

The asymmetric lowest type of organism changes its form continually and is the " sport " of its environment; the centro-symmetric, axo-symmetric, and plano-symmetric form gradations in which the organism becomes more definite and permanent in shape, as it becomes less dependent on its environment and more voluntary in its actions. Lastly, a purely stereo-symmetric organism (with a stereo-symmetric ontogeny), the possible product of future evolution, will have so far freed itself from the effect of its environment that changes in the latter will no more affect its morphological plan (complete heterogeneity). The homogeneity of structure will then have passed from the three dimensions of space to the so-called " fourth dimension " of time.

The study of animal symmetry points to no conclusion more clearly than the future development and predominance of the stereo-symmetric individual, in which the fundamental stereo-symmetry of the physical unit has extended itself to the morphological stereo-symmetry of the organism.

The University,
St. Andrews.

FRESH FACTS.

A NEW AMOEBA IN MAN. J. IJIMA.—"On a new Rhizopod Parasite of Man—*Amoeba miuria*, n. sp." (*Annot. Zool. Japon.* ii. (1898), pp. 85-94). This parasite was found in abundance in the serous fluid-accumulation of the peritoneal and pleural cavities in a case of peritonitis and pleuritis endotheliomatosa, but probably had its headquarters in the tumour tissue. Its nearest allies seem to be *A. villosa*, Wallich, and *A. fluida*, Gruber.

RESPIRATORY TREES OF HOLOTHUROIDS. L. BORDAS. — "Anatomie et fonctions physiologiques des organes arborescents ou poumons aquatiques de quelques Holothuries" (*C. R. Ac. Sci.* cxxvii. (1898), pp. 568-570). At the marine laboratory of Endoume (Marseille), Bordas made a number of observations and experiments on *Holothuria impatiens*, Gmelin, *H. Poli*, Delle Chiaje, *H. tubulosa*, Gmelin, and *Stichopus regalis*, Selenka, and succeeded in showing that the arborescent organs, which develop as diverticula of the gut, have at least four important functions. They are respiratory, as most zoologists have recognised; they have a hydrostatic function when the body expands; they produce numerous amoebocytes; and they are excretory, as is shown by the presence of uric acid and urates.

MUD FROM JERUSALEM. E. ATKINSON.—"Extraordinary Vitality of Entomostraca in Mud from Jerusalem" (*Ann. Nat. Hist.* ii. (1898), pp. 372-376). Forty years ago Mr. Atkinson took some samples of mud from the ancient pool of Gihon, outside the Jaffa Gate of Jerusalem, which at that time contained water during only two months of the year. The dry mud was sent to England and moistened, with the result that six new species of living Entomostraca were detected by Dr. Baird. For eight years in succession, at the Leeds Philosophical Society's Museum, the mud was dried up in summer and moistened again in spring, and its tenants still persisted. In one case a small sample was left dry in a pill box for nine years, and then moistened, with the result that in a fortnight a single specimen of *Estheria gihoni* made its appearance. In another case, the alternation of drought and moisture was kept up artificially for twenty-four years, with unvarying success as regarded persistence of vitality.

GRAFTING INSECTS. HENRY E. CRAMPTON, Jun.—"An Important instance of Insect Coalescence" (*Ann. New York Ac. Sci.* xi. (1898), pp. 219-223). In about twenty cases out of nearly two hundred experiments, Mr. Crampton succeeded in effecting a grafting or coalescence of lepidopterous pupae, similar to that obtained by Born with the embryos of Amphibia. He has proceeded to inquire whether in such coalescence the colours of one moth could be made to replace those of another by a transfusion of haemolymph. In a series of over 750 experiments one case of exceptional interest occurred. A pupa of *Callosamia promethea* was united "in tandem" anteriorly to a pupa of *Samia cecropia*, the

two being kept together by means of melted paraffine applied to the edge of the common wound. The result, as regards coloration, was that while the *cecropia* exhibited, as far as could be determined, the normal specific colours, portions of the *promethea* wings presented the colours characteristic of only the wings of *cecropia*.

Mosquitoes and Malaria. B. Grassi.—"La malaria propagata per mezzo di peculiari insetti" (*Atti R. Accad. Lincei* (*Rend.*) vii. (1898) pp. 234-240). Prof. Grassi has published a second preliminary note in support of his important theory that various "mosquitoes" (*Anopheles claviger*, *Culex penicillaris*, and *Culex malariae*) are agents in spreading malaria. He takes account of other workers who have suggested this.

Pearl-Making. Louis Boutan.—"Production artificielle des perles chez les Haliotis" (*C. R. Ac. Sci.* cxxvii. (1898) pp. 828-830). By "trepanning" the shell and introducing minute spherules of nacre, Boutan was able to induce the formation of "really fine pearls," which cannot be called false.

Pigmentation of the Mussel. Victor Faussek.—"Ueber die Ablagerung des Pigmentes bei Mytilus" (*Z. wiss. Zool.* lxv. (1898) pp. 112-142). A number of experiments show that the formation and deposition of pigment in the mantle, gills, and other parts of the common mussel is not at all affected by alterations in the light, but is in part regulated by the variable degree of exposure to oxygenated water, taken in connection with the distribution of the blood-vessels.

Respiration of the Lamprey. E. Couvreur.—"Étude sur la respiration des poissons. Mécanisme respiratoire chez les Cyclostomes" (*Ann. Soc. Linn. Lyon*, xliv. (1898) pp. 105-109, 2 figs.) In the young lamprey, in the Ammocoete stage, the respiratory movements occur about eighty times a minute, mounting up to a hundred during excitement, but are occasionally suspended for a considerable period. During inspiration the lingual piston is projected, the body-walls expand, the spiracula (external apertures) are opened by the relaxation of the sphincters, and the oscula (apertures into the respiratory tube) are opened by the forward movement of the piston. The water then enters the branchial sacs by the spiracles and oscula simultaneously. During expiration the piston retracts, the spiracles are slightly open, the oscula are closed. The water then passes out by the spiracula. When the lamprey is fixed by its mouth it expires and inspires only by the spiracula, as Duméril observed long ago. Couvreur adds the interesting note that the retraction of the piston corresponds to the systole, and its projection to the diastole of the heart.

Syncytia in Development. W. His.—"Ueber Zellen- und Syncytienbildung. Studien am Salmonidenkeim" (*Abh. K. Sächs. Ges. Wiss.* xxiv. (1898) pp. 401-468, 41 figs.) In this important and beautifully illustrated paper, Prof. His discusses syncytia, *i.e.* "complexes of mutually connected histological units or plasmochores, which are distinctly separated from one another by limiting areas or diastemas." Their primary origin is from incomplete processes of division, but they may also arise secondarily by the marginal coalescence of previously distinct cells. Both types occur abundantly in the blastoderms of fishes. The paper ends with the weighty statement that syncytia and pluripolar nuclear divisions, and giant-nuclei or syncaryoses, are associated phenomena, always implying the occurrence of intense plasmic activity and favourable nutritive conditions.

ONE IN THE EYE. FRANK FINN.—"Note on the Long-Snouted Whip-Snake" (*Dryophis mycterizans*) (*J. Asiat. Soc. Bengal*, lxvii. (1898) pp. 66-67). Mr. Finn had two of these (harmless ?) snakes in his hands, and was holding them gently, when the larger one, which had previously struck at his hand, made a sudden dart at his eye. As he instinctively closed the threatened organ, the snake only succeeded in making two small bites on the upper eyelid and one on the lower. It left one of its teeth, rather over $\frac{1}{20}$ inch in length, but this proved not to be a grooved one. No inconvenience was felt. Mr. Finn thus unexpectedly verified what is a common belief in India that the whip-snake strikes deliberately at the eye, an interesting trait which, as the author notes, is not alluded to by either Dr. Günther or Mr. Boulenger in their accounts of the Indian Reptilia.

A PROBLEM OF SEX. R. W. SHUFELDT.—"On the Alternation of Sex in a Brood of Young Sparrow-Hawks" (*Amer. Nat.* xxxii. (1898) pp. 567-570, 1 fig.) In a brood of *Falco sparverius* Dr. Shufeldt found that the oldest of the five was a male, the next a female, and so on in regular alternation. He inquires whether the alternation is the rule, and, if so, what the correct interpretation of it can be.

THE KANGAROO'S VOCAL CORDS. JOHNSON SYMINGTON.—"The Marsupial Larynx" (*Journ. Anat. Physiol.* xxxiii. (1898) pp. 31-49, 8 figs.) From among the many interesting facts stated in this paper we select one—that the vocal cords of pouch specimens of *Macropus bennettii* are well developed, while the adult vocal cord must be regarded as a degenerated structure. "This is interesting in connection with the well-known fact that these animals are voiceless, and it suggests the theory that they are descended from a stock which possessed a voice."

SOME NEW BOOKS.

BARK-BEETLES

De Danske Barkbiller (Scolytidae et Platypodidae Danicae). By E. A. LØVENDAL. 4to, pp. xii. + 212 with figs. and 5 pls. Copenhagen, 1898.

From the earliest period of modern natural history research the Bark-beetles have attracted much attention. Their importance as widespread destroyers of trees (rarely of other plants, as in the case of *Xyleborus morigerus*, an exotic species now only too common among Dendrobiums in European hot-houses), and the singularity of their burrows in bark or wood have given rise to a literature, beginning with the last century tracts on the "Wurmtrockniss" or destruction inflicted on conifers by various species of *Ips* (*Tomicus*), which is of surprising extent, and with which, concealed as much of it is in obscure periodicals on Forestry, etc., it is difficult to obtain a competent acquaintance. For all but historical purposes, however, it may be said to begin with Ratzeburg's "Forst-Insekten," a work which laid the foundation for the scientific study of forest entomology.

With entomologists not concerned with economic work the study of this family has not proved popular, and it is only in the last thirty years or so that anything has been known about extra-European species. This is not surprising, for the insects are small and obscure, and often so alike in appearance, that they cannot be satisfactorily determined except after prolonged study, not only of the simpler external features, but of the mouth-parts, antennae, and legs, a task requiring much tedious and exacting microscopical work.

They are nevertheless well deserving of study by every one who is prepared not to measure the importance of systematic work by the showiness of the collections on which he is engaged. Accurate determination is the first necessity in the case of many economic problems presented by these beetles; indeed, without it divers of them are incapable of solution. And even if the European species present no great variety of structure, the exotic forms sometimes exhibit a singularity that is scarcely exceeded by any family of Coleoptera.

The habits of the ordinary bark-burrowing Scolytids are peculiar among beetles; still more strange are those of the wood-borers, who, though they tunnel, do not feed on wood but on fungus growths, which, as Habbard has lately shown, are artificially propagated by the insects themselves.

In *Xyleborus*, one of the best known of the wood-boring and "ambrosia-feeding" genera, the males are sub-apterous, dwarfed, and often of bizarre form (in *X. morigerus* the male is relatively so minute that it might be mistaken for an insect of a different genus or even family from the female). Moreover, they are very much the rarer sex, their numbers varying from one in four to one in fifty, or thereabouts; the species are therefore polygamous, and must in most cases inbreed, a fact which does not prevent the genus from being one of the richest and most widely-distributed of the Scolytidae.

One other peculiarity of the family may be selected for mention. In about a half of it, certain deviations from the normal type of structure, such as great antennal development, excavation of the forehead or its decoration with hair-tufts, are, so far as is known, diagnostic of the males; in the other half precisely similar characters when present occur in the females. The line of demarcation between these halves appears to be arbitrary, and this counter-change of sexual characters in different portions of the same family has given rise to some little confusion, and is not the least interesting of the many biological problems provided by the Bark-beetles.

To the late Wilhelm Eichhoff, more than to any one else, is due the present state of our knowledge of these insects. By profession a forester, he supplemented his necessary familiarity with their economy by careful systematic study, and was the first to make a thorough investigation of their oral and antennal structure, and, together with Chapuis, to compile really competent descriptions of exotic species. Eichhoff's *Ratio, &c., Tomicinorum*, published in 1879, is a model of accurate diagnosis, and it is surprising with what ease and certainty the species of the very difficult Tomicinæ are to be identified thereby.

Two years later Eichhoff published "Die Europäischen Borkenkäfer," an account written on less technical lines of the habits, economy, and characters of the European species, and indispensable to the worker at forest entomology.

In the handsome quarto before us Mr. Løvendal, of the Copenhagen Museum, has done on a more extensive scale for the bark-beetles of Denmark what Eichhoff did for those of Europe; and we can but regret that the utility of the book is restricted by the comparatively little known language in which it is entirely written. Mr. Løvendal has aimed at exhaustiveness of treatment both in his descriptions of the insects, at least so far as their external characters are concerned (for he does not follow Lindeman of Moscow far in that writer's elaborate and not very productive researches on internal anatomy), and in his accounts of their life-histories and economic relations. So far as we can judge, he has fully succeeded; and the labour devoted to the book may be estimated by the fact that the list of works cited numbers close on two hundred, in which we have not detected any important omission.

The book, like that of Eichhoff, is furnished with full, perhaps even unduly elaborate, tables of generic and specific characters, and for identification of the species by means of their galleries and the kinds of tree attacked. In its plan it closely follows its predecessor, so that those who know that useful work will know what to expect here, though they will probably be surprised at the scale on which it is carried out.

Not its least valuable part is the full information given as to distribution both within and without Denmark, the author having consulted all papers throwing any light on this subject. We notice however, that, though he records the existence of *X. saxeseni*, Ratz., in North America, he, like most European entomologists, is unaware that it was first described there, and should bear the name of *X. xylographus*, Say.

The number of species recorded from Denmark is fifty-one; this is about equal to the number in the British Isles, about a dozen species in each fauna not being found in the other. It is likely that further research will increase the number known from Denmark, as several species not recorded by Løvendal may be expected to occur there. One species only is peculiar, *Ips elongatus*, Løv.; this has been treated by Reitter as synonymous with *Ips austriacus*, Wachtl., an identification which Løvendal does not accept.

The text is illustrated with numerous pictures of burrows in bark and wood, partly original, and partly copies. The galleries of several species are, we believe, illustrated for the first time.

But perhaps the most striking feature of the whole work is that of the five plates, drawn and engraved by the author in a manner now rarely to be seen in

entomological works, but familiar to those who know Løvendal's plates to his countryman Schiødte's "De Metamorphosi Eleutheratorum." No more beautiful or accurate illustrations of these insects, so hard to delineate successfully, have ever been made, and they alone entitle the book to distinction.

To write a discriminating notice of a work in a language that one can read but slowly and laboriously is impossible. But, so far as we have been able to form an opinion, we cannot say less than that we regard this work as one of the most thorough and perfect faunistic monographs it has ever been our good fortune to examine. It furnishes the Danish entomologist with everything he can require to know on these interesting and important little beetles. It may be added that its publication has been rendered possible by a State subsidy from the Carlsberg Fund. W. F. H. Blandford.

ANOTHER TEXT-BOOK OF BOTANY.

An Elementary Text-Book of Botany. By Sydney H. Vines, M.A., D.Sc., F.R.S. 8vo, pp. xv. and 611, with 397 illustrations. Sonnenschein and Co., London, 1898. Price 9s.

Those of us who remember the old "Prantl and Vines" which, fifteen years ago, was perhaps the most generally used elementary text-book in medical schools and colleges, will scarcely recognise any resemblance to it in the present volume. This is not a new edition of the old translation from the German of Prantl, but a new text-book brought almost as nearly up to date as is possible for an elementary work. It vividly recalls the Students' Text-Book of 1894-95, and is, so to say, a carefully edited abridgment of the latter. Difficult and debatable topics have been omitted, the more fundamental recent discoveries have been incorporated, and there has also been some rearrangement of the subject matter. The result is a diminution in bulk by one quarter, and a presentation of the elementary facts of botany in so complete a manner as to place the Students' Text-Book at 16s. in the position merely of an *édition de luxe.* In fact, the author has created the necessity for the more advanced and larger edition of the latter which he contemplates in his preface, and which we shall hope to review at no very distant period.

As *Natural Science* has already noticed at some length the Students' Text-Book (see vol. iv. p. 376, and vol. vi. p. 424), and the present work is on the same lines, it will be sufficient to note here the main points of difference between the two. Modern tendency is to bring as nearly together as possible the stories of form and function. Van Tieghem, in his most recent text-book on Botany, has incorporated them in one section, and discusses *seriatim* the morphology and physiology of the various plant-members. This mode of treatment, though doubtless the most scientific, has many disadvantages. Professor Vines does not attempt it, but we are glad to see that the section on Physiology is brought from the end of the book, and follows that on Morphology and Histology. These first three parts, dealing respectively with general form, anatomy and histology, and physiology, leave little to be desired. The confusion over the Stelar theory, which has bothered so many students in the larger work, is here avoided, doubtful points relating to the minute structure of the cell are omitted, and a tangible physical explanation is given of the ascent of the sap, based on the recent work of Messrs. Dixon and Joly. In Part IV. (Classification) we are a little disappointed to find no revision of the sub-classes Algae and Fungi, and in Group II., Bryophyta, we should like to have seen a fuller description of at least one typical thalloid and foliose member of the class Hepaticae.

In the treatment of the Seed-plants, account is taken of the recent discovery of motile male cells in the Cycads and Conifers, and two distinct groups, each comparable with Bryophyta or Pteridophyta, are now recognised under the old class-names Gymnospermae and Angiospermae. The general introduction to

these groups is excellent, but the arrangement of the sub-classes and cohorts of the Monocotyledons and Dicotyledons is open to criticism. The author has "thought it desirable to follow, in the main, the classification laid down in the *Genera Plantarum* of Bentham and Hooker," one of the classics of Systematic Botany, but a work which occupied half a lifetime, and was completed fifteen years ago. As in Morphology and Physiology, so in the study of the affinities of the families of seed-plants, much has been done in the interval, and some expression of this should find place in an elementary text-book.

THE COMPLETE GENEALOGIST.

Lehrbuch der gesammten wissenschaftlichen Genealogie. Stammbaum und Ahnentafel in ihrer geschichtlichen, sociologischen und naturwissenschaftlichen Bedeutung. By Dr. OTTOKAR LORENZ, Professor der Geschichte. 8vo, pp. ix. and 489. Berlin: Hertz, 1898.

More than a hundred years ago, as Dr. Lorenz tells us, Gatterer of Göttingen wrote a text-book of genealogy for the use of his students. And, strangely enough, this old book has remained until now the only systematic treatise on the subject. It was high time that there should be a new "Gatterer," and this our author has supplied, to the gratification of a wide circle of students, whether of history, or heraldry, or heredity. Dr. Lorenz discusses "genealogy as a science," "the theory of the genealogical tree," "tables of ancestry," and "the bearing of genealogical studies on heredity." He deals very judiciously with modern theories of heredity, inclining on the whole to agree with Weismann; and makes a strong case for the advantage of genealogical studies to supplement those which are purely statistical. In our judgment he does not fully appreciate the importance of Mr. Galton's work, especially as regards "the law of ancestral inheritance." X.

THE GEOLOGIST'S VADEMECUM.

Aids in Practical Geology. By GRENVILLE A. J. COLE. Third edition. 8vo, pp. xvi. and 432, with coloured frontispiece and numerous illustrations. London: C. Griffin and Co., 1898. Price 10s. 6d.

Good wine needs no bush, and Professor Cole's excellent adjunct to the text-book and the laboratory, having now reached its third edition, requires little further commendation from us. The first edition was published in December 1890; the second in April 1893. The present edition is enlarged by several pages, and is revised throughout. New inventions of apparatus are introduced in the text, and the more recent literature referred to in the footnotes. A good deal of improvement and extension is visible in the palaeontological part, which is better than most English text-books of equal size. Nevertheless we are not sure that we understand the reason for this section. It would not really be of much use in the field; and it is certainly not a guide to laboratory practice or to original investigation. Still we have little fault to find with it, except that the true scale of the various figures is not indicated. On the whole we should recommend Professor Cole to reduce those portions of his book that cover ground which is, or ought to be, covered by the ordinary text-book, and to amplify the strictly practical chapters, which already are admirable.

Dr. John Anderson has completed his researches on the Reptilia and Batrachia of Egypt, and the results form volume one of the *Zoology of Egypt*, which has just been announced by Bernard Quaritch. Only 100 copies have been printed, and the price is £12 : 12s., which is quite prohibitive. Some 1500 specimens were collected, the greater part of which are now in the British Museum.

Students of the Foraminifera will be glad to learn that the *Société de Naturalistes de Kiew* (Kieff), Russia, have decided to publish a continuation of Sherborn's *Bibliography of the Foraminifera*, from 1888-98. The compilation has been undertaken by Dr. Paul Tutkovski, whose work on the Russian tertiary and cretaceous Foraminifera is well known, and who has been in frequent communication with Mr. Sherborn and other workers. We may therefore look forward to a full and complete additional list which will be of much service and value.

The fifth year of the *Bibliography and Index of North American Geology, Palaeontology, Petrology, and Mineralogy*, that for 1897, has just appeared. It forms the 156th *Bulletin of the United States Geological Survey* and is compiled by Fred Broughton Weeks. There are 742 separate titles which are placed in alphabetical order under authors, and these titles are analysed in 40 pages of index. The whole forms a compact and handy Bibliography in an inexpensive and practically useful form.

Science Progress: a Monthly Review of current Scientific Investigation, changed some time ago into a quarterly, and now, to the considerable loss of its writers and readers, disappears from the scene. Instead, there enters *Science Work: a Monthly Review of Scientific Literature*, published by Robert Aikman and Company, Manchester, and edited by Waller Jeffs. This is to afford a practical guide to publications in the English language on all branches of natural and social science. The subscription is three shillings a year; if prepaid, half-a-crown, post free. It will doubtless prove useful to those who wish to know what is appearing in the magazines. May we express a hope that our next fellow-worker in this field will choose a title less reminiscent of *Natural Science: a Monthly Review of Scientific Progress?*

Mr. Wilfrid Mark Webb has given up the editorship of the *Journal of Malacology*, as well as his position under the Essex County Council, and has removed from Brentwood to 2 The Broadway, Hammersmith. He is temporarily engaged on work at the museum of Eton College. *The Journal of Malacology* passes again into the hands of Mr. W. E. Collinge and also becomes in part the organ of the Midland Malacological Society, which was founded on July 7, 1898, with Mr. Collinge as president, and Mr. H. Howard Bloomer as secretary. The first number of vol. vii. of the *Journal* was issued on December 2. It contains "Descriptions of a New Species of *Cryptosoma* (*C. austeni*)," by W. E. Collinge; a reprint of the description, with figures, of "Species of *Plectopylis* recently described in *Science Gossip*," which does not give the dates of the original publication, an unfortunate omission considering the vagaries that have from time to time affected the issue of our estimable contemporary. The Bibliography of current Malacological literature is now restricted "to books and papers sent in by their respective authors, and those of special interest in the current magazines, etc." There is much virtue in an "etc."

We have received Volume xi. of the Memorias y Revista de la Sociedad Cientifica Antonio Alzate, including a new theory of respiration, by Prof. A. L. Herrera and Dr. D. Vergara Lope; a description of the volcanoes Colima and Ceboruco, by E. Ordóñez; a case of pulmonary tuberculosis cured by the action of rarefied air, by D. Vergara Lope; Metamorphoses of *Papilio daunus* and note on the staminal dimorphism of *Solanum cornutum*, with a plate, by L. G. Seurat; seismic observations made at Orizaba in 1895, by C. Mottl; albinism in the squirrel, with plate, by A. Dugès; the origin of individuals: the construction of the organism through internal conditions, by A. L. Herrera; seismic study of Central and South America, by F. de Montessus de Ballore.

Mr. F. H. Perry-Coste publishes in the December number of *Nature Notes* an interesting account of Philip Miller, "Gardener to the Worshipful Company

of Apothecaries at their Botanical Garden at Chelsea, and F.R.S.," and of his views on the circulation and nature of sap, as published in the second edition of his "Gardener's Dictionary," 1733.

The Society Carlos Ribeiro at Porto, Portugal, has changed the title of its organ from *Revista de Sciencias Naturaes e Sociaes* to *Portugalia: Materiaes para o Estudo do Povo Portuguez.* It will be devoted entirely to the anthropology and ethnography of the Portuguese race.

Věstnik slovanskych starožytnosti means "Review of Works on Slavonic Antiquities," and is a journal of which the first part has just been published at Prague, under the editorship of Prof. L. Niederle; most of the reviews are in French and German.

Mr. G. W. Bulman contributes to the December number of the *Westminster Review* a criticism of the late Professor G. H. T. Eimer's theory of organic evolution.

The *American Anthropologist* is to be succeeded by a new Journal, in quarterly numbers of about 200 octavo pages, published by G. P. Putnam's Sons, and conducted by the following editorial board:—F. Baker, F. Boas, D. G. Brinton, G. M. Dawson, G. A. Dorsey, W. H. Holmes, J. W. Powell, F. W. Putnam, with F. W. Hodge as secretary and managing editor. The first number is to appear in January. The annual subscription is $4.

No. 137 of vol. xviii. of *Johns Hopkins University Circulars* is devoted to "Notes from the Biological Laboratory," edited by Prof. W. K. Brooks, and "Notes from the Geological Laboratory," edited by Prof. W. B. Clark. The contents include the following papers:—"Some Ectosarcal Phenomena in the Eggs of *Hydra*," by E. A. Andrews, dealing with filose and amoeboid activities. "The Echinoids and Asteroids of Jamaica," a systematic list, with general notes, by H. L. Clark; no new species are described, but if we are to judge from the mode of printing the names, all the species are referred to genera other than those in which they were placed by the original describers. "Embryology of *Ophiocoma echinata*, Agassiz," by C. Grave; the abundance of apparently normal larvae having two anterior coelomic sacs, each communicating with the exterior by a dorsal pore-canal, is a point of much interest. "Notes on the Ophiurids collected in Jamaica during June and July 1897," by C. Grave; this resembles Dr. Clark's list, but all the species appear to be left in their original genera. E. W. Berger abstracts the late "Dr. F. S. Conant's [MS.] Notes on the Physiology of the Medusae." L. E. Griffin publishes "Notes on the Tentacles of *Nautilus pompilius*," preliminary to a complete account of the anatomy of the nautilus. The chief article in the geological section is entitled "An Episode during the Terrace Cutting of the Potomac," by Cleveland Abbe, jun. The price of this number is 10 cents, post free.

A Catalogue and price-list of the papers of the late Professor Edward D. Cope, arranged chronologically, also price-list of Plaster Casts, has been sent to us by Mrs. E. D. Cope, Haverford, Pa., U.S.A. The papers are to be had for very moderate prices, and the complete set costs seventy-five dollars. The casts may be ordered white, or carefully coloured after the originals.

The list of papers is a useful bibliography, but it is naturally far from complete, and it is marred by an excessive number of reprints. A writer so voluminous as Cope, making his important contributions to knowledge in a multitude of small scattered papers and notes, deserves a special bibliography prepared by an expert. We commend the suggestion to the notice of the Smithsonian Institution, which has already issued several valuable bibliographies of this kind.

OBITUARIES.

WILLIAM GUYBON ATHERSTONE.

BORN 1813; DIED 26TH JUNE 1898.

THE Hon. William Guybon Atherstone, M.D., F.R.C.S., F.G.S., and Hon. Vice-President of the Geological Society of South Africa, died in the 85th year of his age, at his residence in Beaufort Street, Grahamstown, Cape Colony. In 1839, after settling in medical practice at Grahamstown, Dr. Atherstone met Staff-Surgeon Jameson, who was studying local geology, and he became interested in the science. A year or two afterwards Mr. A. G. Bain brought his wonderful reptilian fossils to Grahamstown, and Dr. Atherstone took up the subject earnestly. Bain states, in a lecture at that city in 1856 (reprinted in the *Trans. Geol. Soc. S. Africa*, vol. ii. part 5, 1897, p. 66)—"He said he was now determined to study geology, and should begin forthwith; and well has he kept his word, for I never met with one who made such astonishing progress in such a short time. From that day an intimacy began between us, which soon ripened into a friendship which, I trust, may never cease while we live." He goes on to say—"My friend Bochards [of Fort Beaufort] and myself had now added to our ranks the transcendent talents of Dr. Atherstone, which soon imbued our minds with elevated ideas, and gave fresh vigour and stimulus to our pursuits."

Grahamstown also supplied, in Mr. W. Ogilvie, another friendly sympathiser for Mr. Bain; and indeed this city has been termed the birthplace of South African geology; for the hearty recognition given to Mr. Bain's geological researches by the Geological Society of London stimulated others to collect fossils and examine sections throughout the country. Thus one geological society was started at Grahamstown by Dr. Atherstone, and one at Graaf-Reynet by Dr. R. N. Rubidge (afterwards of Port Elizabeth). For many years, both in the prime of life and in old age, when afflicted with blindness, Dr. Atherstone not only willingly, but enthusiastically, gave all the help he could to the establishment and well-being of the Albany Natural History Museum and the Public Gardens in Grahamstown.

Soon after their first meeting, Atherstone joined Bain in a geological visit to the Gamtoos, Bushman, Sunday, and Zwartkop Rivers, where Jurassic and Tertiary fossils were found in plenty. Interesting notes of the journey appeared in the *Eastern Province Monthly Magazine*, and the fossils have been described in the *Transactions* and *Journal Geol. Soc. London*. Further, a systematic account of the Uitenhage series of strata and their fossils in the district traversed by the above-mentioned rivers was published in the *Quart. Journ. Geol. Soc.* vol. xxiii. (1867), pages 149-171. He became a Fellow of the Geological Society of London in 1864.

Atherstone and Rubidge visited Namaqualand to examine the copper-bearing rocks, and reported on them in 1857. The Kasonga and the Alum Caves in the Eastern Province were also visited by Atherstone in or about 1858. In

1875 he came to England, having been officially requested to gather information about lunatic asylums, in view of the erection of a new one in the Colony.

With reference to his many presentations of good reptilian fossils to the British Museum, a well-deserved tribute of praise has been given to Dr. Atherstone by Sir Richard Owen in his *Descript. and Illustr. Catal. Foss. Reptilia S. Africa*, 1876, p. vi., where he says: "It will be seen how largely Science and the British Museum are indebted to W. Guybon Atherstone, Esq., M.D., who has devoted the leisure of a long and successful medical practice at the Cape to the study and acquisition of evidences of the palaeontology of that part of the globe."

Through Dr. Atherstone's intelligent interest, in response to those who knew him as a geologist, the accidental occurrence of the now historic diamond at De Kalk, in the Hopetown Division of the Cape Colony, was brought to light in 1867. He was the first to determine its characters as a real diamond. Fully recognising the importance to the Colony of such a discovery, he suggested that it should be sent to the Paris Exhibition, and the Governor of the Colony secured it by purchase. The enormous wealth accruing to South Africa from this fortunate application of mineralogical knowledge and common sense is now too well known to be further dwelt upon.

In 1871, when he made his first visit to diamond fields, he noticed that Jägersfontein was being deserted by the diggers. He assured them it would be a good mine; and, when it was again worked eight years afterwards, it proved to be very productive. He also indicated the diamantiferous neck at "De Beer's New Rush," afterwards called Colesberg Kopje, and ultimately Kimberley. Subsequently, after he had become a Member of the Cape Parliament, he again visited the diamond mines—that of Kimberley in particular, with its deep shafts and numerous galleries; and he contributed many interesting notes to the local publications on the possible origin of the diamonds, and the causes of the disastrous "mud-rushes" deep down in the mine, as well as on some of the physical phenomena of the surface.

In the meantime he had visited the Gouph and the reported gold-bearing rocks of that and other localities, as far as Lydenberg, everywhere bringing his long experience and mature judgment to bear upon geological difficulties with more or less advantage. Dr. Atherstone took a warm interest in establishing the Geological Society of South Africa at Johannesburg in 1895; and he was elected an Hon. Vice-President at their first meeting.

We may well regard our old friend as one of those prominent geological worthies who have given their best energies to the elucidation of South African geology and to the benefit of their fellow-men. T. R. J.

GEORGE JAMES ALLMAN.

BORN 1812; DIED 24TH NOVEMBER 1898.

THE last of the brilliant band of Professors who, under the Chancellorship of Lord Brougham, the Rectorship of Mr. Gladstone, and the Principalship of Sir David Brewster, a galaxy of talent unrivalled, made the scientific and medical sides of the great Scottish University everywhere known and esteemed, —the cultured and refined George James Allman passed away on the 24th November, at the age of 86. He was born in Cork, and spent his school days in Belfast; and his original intention was to study for the Irish Bar. But the natural bent of his mind was towards botany and zoology, and he graduated in Arts and Medicine in the University of Dublin in 1844. His earlier papers were partly botanical, and this led to his appointment (1844) as Regius Professor of Botany in the University in which he had studied. He also at this time gave much attention to the fresh-water Polyzoa, though there is considerable variety in his first fifty papers. Amongst the memoirs which his

fertile pen produced at the time, was that on the Anatomy and Physiology of *Cordylophora*, in which he gave an indication of his masterly treatment of the Tubularian Hydroids. When the somewhat sudden and lamented death of Edward Forbes took place, in the midst of his enthusiastic labours in his new sphere of action in the University of Edinburgh—surrounded as he was by congenial colleagues, and with a great future before him, Dr. Allman had sufficient influence in 1885 to obtain the appointment. Though, at first, opinions as to the successor of the brilliant Forbes were divided, yet Allman, by the publication of his volume on the Fresh-Water Polyzoa (Ray Society, 1856), a model of its kind in text and illustrations, at once gained support and disarmed criticism. His genial and courteous bearing, and the eloquence he displayed in his lecture-room, made his courses on Natural History exceedingly popular, and he, besides, occasionally conducted dredging excursions on Saturdays in the Forth with his students, a steam vessel being hired at Leith for this purpose. He was ever ready to explain and instruct as the dredge or otter-trawl came up, and many a young student of the "fifties" must retain pleasant memories of these delightful expeditions. Nor were his sympathies—with those who retired from active service as the trawl settled into action—more likely to be forgotten. Moreover, he devoted a short part of the next lecture to the most instructive forms met with in the excursion, illustrating his remarks by sketches on the blackboard. No professor, indeed, was more welcomed by the student of the day, and many still recall his once familiar figure as he hastened—not much before time—from Manor Place through the Grassmarket to the high class room in the Old University. Besides his University and more purely zoological work, he took much interest in the Scottish Fisheries, and was appointed a Commissioner to inquire into various subjects connected with the department. One of them was the investigation, along with Prof. Lyon Playfair, of the spawning-ground of the herring at the "Old Hake," near Crail. While pursuing this inquiry, he hatched the eggs of the herring quite easily in a simple apparatus. He also took an active part in transferring the zoological collections of the Old University Museum (so dear to many an old student) to their new quarters in the Museum of Science and Art. At the meetings of the Royal Society in Edinburgh he worthily upheld the traditions of the chair of Walker, Jamieson, and Forbes, his wide and accurate zoological knowledge and his fluent and graceful style combining to render him as trenchant as agreeable. Not a few regretted his somewhat early retirement from a post in which he was so fitted to distinguish himself, but considerations of health compelled him to resign his chair in 1870.

The comparative leisure which he enjoyed after his departure from Edinburgh enabled him to devote his whole energies to his favourite studies, while also advancing the general interests of science by his able Presidency of the Linnean Society, and by his occupation of the Presidential Chair of the British Association at Sheffield in 1879.

As a zoologist Prof. Allman brought to bear on his subject a cultured intellect, keen observation, philosophic spirit, and sound deduction, while his gifts in artistic delineation of the beautiful forms to which he specially devoted himself give his works a solidity and a charm all their own. These features, for instance, are prominent in his beautiful monograph of the Tubularian Hydroids for the Ray Society (1871-72), a work at once an honour to British zoology and an enduring monument to the talents and refined artistic touch of a master in the department. Marine zoology, indeed, has lost in him its foremost investigator and its most dignified expounder in our country. Himself a graduate in medicine, he fully appreciated, as shown in his introductory lecture in Edinburgh, the brotherhood of zoology and medicine, a feature the late Universities (Scotland) Commissioners have apparently misunderstood.

Of a somewhat delicate constitution, he shrank from those combats in which men like Prof. Huxley flourish, but in general society there were few so genial

and kindly, so full of sparkling Irish humour, and so refined and engaging in conversation. He was the last but one of the band of those older naturalists which included Edward Forbes, George Johnston, George Busk, W. Thompson, J. S. Bowerbank, J. Gwyn Jeffreys, P. Gosse, John and Harry Goodsir, Thos. Bell, Joshua Alder, Albany Hancock, Spence Bate, Thos. Hincks (still living), and others, who, by their genius and perseverance, have done so much to bring British marine zoology to its present position. Of all these none were closer friends than George Busk and James Allman, and they were worthy of each other.

W. C. M'INTOSH.

CARL WILHELM VON GUEMBEL.

BORN FEBRUARY 11, 1823, AT DANNENFELS ON DONNERSBERG IN THE RHEINPFALZ; DIED JUNE 18, 1898, AT MUNICH.

AFTER half a century of active work in all branches of geological science, this eminent naturalist has passed away at the age of 75. After receiving a school education at the Gymnasium in Zweibrücken, he studied the art and science of mining at Munich and Heidelberg, and in 1848 received his first appointment at the collieries of St. Ingbert. His first scientific paper, however, was on his native Donnersberg. In 1851 he was called to the direction of the Land-Survey at Munich, and in 1879 was made "Oberbergdirektor" of Bavaria. To this kingdom his chief energies were devoted, and he received the reward of nobility in 1882. In addition to his civil posts, Von Guembel was honorary professor at Munich University and teacher at the Technical College.

The list of his scientific works is too large even for abstraction here. He is best known for his "Geognostische Beschreibung des Königreichs Bayern," which was begun in 1861, and developed into the memoirs of the geological survey of Bavaria. His "Geologie von Bayern," 1884-93, served as a geological text-book for the students of that country, as well as a summary most useful to foreign geologists. In addition to writing papers on mineralogical and petrological subjects, he invented instruments of precision for crystallographic optics, and Von Kobell perpetuated the memory of his labours in this field by the mineral name "Guembelite." The name *Guembelina*, applied to a fossil dactylopore, further recalls Guembel's extensive researches on fossils of obscure lower organisms, and his numerous papers on the Foraminifera.

The death was also announced early in December of WILLIAM COLCHESTER, formerly of Dovercourt, near Harwich, a well-known collector of Tertiary fossils. He it was who discovered the *Macacus eocaenus* described by Owen in 1839, and now in the Ipswich Museum. This was afterwards shown to be *Hyracotherium*. *Didelphis colchesteri* was another important find of Mr. Colchester's, and came with the *Macacus* from the Eocene sands of Kyson, Essex. Mr. Colchester became a Fellow of the Geological Society of London in 1857, and was of advanced age at the time of his death, which occurred at his residence, Burwell, Cambridge.

DR. JAMES INGRAHAM PECK, Assistant Professor of Biology in Williams College, and since 1896 Sub-Director of the Marine Biological Laboratory of Wood's Holl, Mass., U.S.A., died suddenly on November 4. He was born at Seneca Castle, Oneida Co., N.Y., August 10, 1863, and studied at Williams College and Johns Hopkins University. He worked chiefly on the food of marine fishes, also on the pteropods and heteropods collected by the "Albatross." His loss is deeply felt by his American colleagues.

The deaths have also been announced of :—On September 16, at St. Gallen, the Swiss Geographer, Prof. R. C. AMRHEIM, aged 53; the French Geographer, J. V. BARBIER; on July 28, the Peruvian Geographer, LUIS CARRANZA, M.D.; Dr. HERMANN ENDRES, Privat-Docent in Anatomy at the University of Halle,

on July 30, aged 32; on December 11, Sir WILLIAM JENNER (*b.* 1815), who has been Her Majesty's physician for upwards of thirty years; JOHN W. KEELY, of Keely Motor notoriety, in Philadelphia, on Nov. 18; Dr. WILHELM KOCHS, Docent in Physiology at Bonn-am-Rhein, on Oct. 15; EDMOND MOLLERAT, Conchologist, at Saint Raphaël, France; on December 24, 1897, in Thorshavn (Faeroe Islands), the ornithologist, HANS C. MÜLLER, aged 79; ALEXANDER PILLIET, Curator of the Anatomical Museum of the University of Paris (Musée Dupuytren) and a writer on morbid anatomy, on Nov. 2, at Paris, aged 38; GEORGE VESTAL, Professor of Agriculture and Horticulture at the New Mexico Agricultural College, on Oct. 24, aged 41; Dr. DAVID A. WELLS, a writer on economics, and founder of *The Annual of Scientific Discovery* (1849-1886, Cambridge, Mass.), also author of a "First Principles of Geology."

CORRESPONDENCE.

VACCINATION.

Sir,—The letter of "U" in *Natural Science* for October gives one very striking exception to the rule laid down in *Natural Science* for September, that "no level-headed person with any capacity for weighing evidence doubts that vaccination, efficiently performed, affords an almost absolute protection against small-pox for a term of five to ten years according to the natural susceptibility of the individual." May I be allowed to pillory a few more?

Dr. William Gayton, giving evidence before the recent Vaccination Commission, in answer to Question 1755, expressed the opinion that "primary vaccination is a very fleeting protection indeed. As to the time that primary vaccination lasts I do not know, but I think it is a very short time."

Dr. R. A. Birdwood, whose experience of small-pox covers 12,000 cases, in answer to Question 31,191, stated that vaccination cannot be relied upon as an absolute protection up to any age whatever.

In addition to those who are not anti-vaccinationists, be it noted there are no less than four M.D.'s on the general Committee of the Anti-Vaccination League, one of whom is Dr. Charles Creighton, author of the article "Vaccination" in the "Encyclopaedia Britannica" (9th ed.), "The Theory and Practice of Vaccino-Syphilis," and other works.

Another is Dr. W. S. Tebb, whose recent work on "A Century of Vaccination" is full of facts marshalled in a masterly manner.

How many M.D.'s there may be as private members I have no means of knowing, but the recent addition of Dr. W. J. Collins, one of the Royal Commissioners and a signatory of the minority report, was recently published, and very naturally made much of.

Dr. Alfred Russel Wallace is another of those exceptions, every one of whom conscientiously objects in a greater or lesser degree to vaccination, and I for one hesitate to say that they do so "in strict proportion to" their "ignorance and inability to weigh evidence."

I quite agree that "were the money necessary to secure compulsory vaccination spent in a reasonable system of education of the masses as to the value of vaccination, it is possible that a larger percentage of vaccinations might be secured than under the present system," but it is very improbable.

One good would accrue from such a course, viz. the impossibility of gaining entrance into a scientific magazine of high standing, such as *Natural Science*, of a sentence like this—"The recognition of *the fact that vaccinia is merely attenuated small-pox*—proved again and again—only brings vaccination into line with what we know of other protective inoculations."—Yours truly, E. G. B.

[We have inserted the above from a sense of fair-play, but *Natural Science* is not the place for carrying on a discussion on the subject, and we must draw the line after alluding to two points:—(1) The duration of the protection afforded by primary vaccination is not to be settled by giving the opinion of

Dr. This or Mr. That, but by a study of attack-rates and death-rates at different age periods in definite epidemics amongst vaccinated and unvaccinated respectively (*see* Statistics of Sheffield Outbreak, by Barry, and of Gloucester Outbreak, by Bond); (2) as regards the identity of variola and vaccinia, *see* Klein's experiments recorded in Medical Officer's Report to the Local Government Board for 1892-93.—ED. *Nat. Sc.*]

CLASSIFICATION OF BUTTERFLIES.

In *Novitates Zoologicae*, v. p. 374, ff. (1898) I published an account of the structure of the antennae of butterflies as a first instalment of my "Contributions to the Morphology of Lepidoptera." I am carrying out these researches on Lepidoptera in order to reach a basis of fact which will enable us to understand the various structures of the exoskeleton of Lepidoptera, and will thus also furnish a better basis for classification. As the number of species to be examined is so very great, oversights are likely to occur; but I hoped that, by inviting criticism of my paper, such oversights would be corrected by others, and thus our knowledge of the morphology and relationship of Lepidoptera be advanced. Criticisms in which errors as to facts are pointed out, or in which it is shown where and why my conclusions are fallacious, will have my earnest consideration.

Professor Grote, in the last issue of *Natural Science*, p. 440, does not give any reason why, in his opinion, the characters of the antennae are "valueless for taxonomy and phylogeny," and hence I have nothing to reply to this strange statement.

As regards Professor Grote's classification of Butterflies I merely say that it remains for Professor Grote to show that what he styles in Papilionidae vein ix. (absent from the other Butterflies, according to Grote) is *not* homologous of what he calls in the other Butterflies vein viii. (absent from Papilionidae, according to Grote). This fundamental question can be answered by a study of the development of the respective veins in the chrysalis. KARL JORDAN.

ZOOLOGICAL MUSEUM, TRING, *December* 6, 1898.

In reply to Mr. Quail's criticism (*Natural Science*, p. 395, December 1898) of my conclusions as to the position of the Papilionides, a criticism based upon his reading of the characters of *Anosia*, I take up these one after another. The "structural blotch A" on the cubitus of *Anosia* may or may not be homologous with the cross vein of the Papilionidae. It is a slight extension at the extreme base, and is more prominent in *Heliconius*, where it really assumes the aspect of the remnant of a cross vein between cubitus and vein vi. In both cases it is situated much nearer the base of the wing than in the Papilionidae. Mr. Quail is correct that I had overlooked it (*l.c.* p. 394). But its exact nature and meaning are unimportant to my classification. I do not base my separation of the Papilionides upon the presence of a cross vein between cubitus and vein vii., but upon the existence of vein ix. in the latter group. There is no trace of vein ix. in *Anosia*, indeed there is no room for it. Again, the homology of the "structural blotch" of *Anosia*, of the Limnads, and Heliconians with the cross vein of the Papilionides would favour my theory that this structure is a part of a former general system of cross veins of the lepidopterous wing, as explained in the *Proc. Am. Phil. Society*. A cross vein would then have run in the Lepidoptera generally between v. and vii., intersecting vi., which latter vein has faded out; and thus the action by which the media has disappeared would have been repeated with variations in the region below the cubitus. The cross vein gradually fades out in the Papilionides themselves and is lost entirely in the higher forms, so I could not have placed any reliance upon its presence in the classification which I proposed. This, I think, disposes of objection "A." As to "B," the "rudimentary nervure," this is equivalent to my vein viii., and does

not touch ix.; with regard to "C," the position of vein i. in *Anosia* and the Limnads, I have especially alluded to this feature of the hind wings, and it again does not meet my point as to ix. of primaries. The main point I make, as against Scudder, Reuter, and others, is that they cannot logically interpolate *Papilio* with its vein ix. between the Blues and Skippers, as they attempt to do, because both these groups are without this vein ix., and, moreover, I have shown that the pattern of neuration of the two, thus violently separated, groups authorises the supposition that they are really related. The assumed dichotomy of the butterflies is another matter. It will be solved when we find vein ix., or when its traces are found in any other butterfly, of which neither Mr. Quail nor any one else has brought forward any evidence. I do not doubt that traces of vein ix. may be found in *Lagoa* or *Megalopyge* or *Cossus*; these are all Tineides (Grote), and I look for the origin of the Papilionides in this group. My theory of the movement of the veins in the wings of the butterflies and Lepidoptera generally is based upon the discoveries of Spuler and Comstock that the media is three-branched and the cubitus two-branched, while the radius is primarily five-branched. Some seeming discrepancies between Mr. Quail's interesting paper and my own communications may arise from a different point of view in this respect. But these are all side issues and do not affect the main issue, which cannot be decided in Mr. Quail's favour, I think, until he produces evidence that the other great group of butterflies, the Hesperiades, possess, or indeed ever possessed, vein ix. of the primary wings. It will not do merely to say that they have lost it; they may have sprung from an ancestry which had equally lost it, while the Papilionides must have sprung from an ancestry which had retained it. A. RADCLIFFE GROTE.

ROEMER MUSEUM, HILDESHEIM, *December* 5, 1898.

[As our space for correspondence is very limited, this discussion cannot be prolonged here.—ED. *Nat. Sc.*]

ARTIFICIAL FORMATION OF A RUDIMENTARY NERVOUS SYSTEM.

Thanking you for the honour done me by the publication of my paper in your review (November and December 1898), I venture to ask you to append the following note:—

Some vibrations of the neuroplasma might be explained by the osmotic currents of Bütschli, increased by the heat afforded by oxidations. Remak has observed that the axis-band has a reticular structure. In that case the theory of carbon dioxide should be rejected, but it would be profitable to make new experiments with an artificial protoplasm, obtained by a combination of the microscopic foam of Bütschli, which presents a *physical* analogy to the natural cytoplasm, and my own, which has a *chemical* analogy to the same, being formed by a mixture of the components of the plasmodium of *Fuligo septicum*, according to Reinke's analysis.

Perhaps the separation of the absorbed substances is effected by the partitions of the protoplasmic alveoli, and if that be true, the protoplasm itself might be compared to a gland, and even induced to grow (?) in a nutritive solution. In support of my position, I would refer to Dr. Loeb's address, the gist of which was published in *Nat. Sci.* xii. (1898) pp. 146-148. May I also correct two errata in my paper?

Page 336, instead of "negative variation of carbon dioxide" *read* "negative variation of nerve."

Instead of "Milne Edwards, *l.c.* vol. xiii. p. 5" *read* "Milne Edwards, *l.c.* vol. xiii. p. 58." A. L. HERRERA.

MEXICO.

NEWS.

THE following appointments have recently been made: — Dr. Cleveland Abbe, jun., to be professor of geology in Western Maryland College; Drs. J. L. Ames, F. A. Woods, R. T. Atkinson, and F. R. Stubbs, to be assistants in the department of histology and embryology at Harvard Medical School, consequent on the resignations of Drs. H. P. Quincey and Elisha H. Gregory, jun.; R. T. Baker, assistant-curator of the Technological Museum, Sydney, N.S.W., to be curator of that institution; Dr. F. J. Becker of Prague to be professor of mineralogy at Vienna University; Dr. Boehmig as professor extraordinarius of zoology at Graz, Austria; Dr. A. Bühler to be privat-docent in anatomy at Würzburg; Dr. Capitan to succeed Gabriel de Mortillet as professor of prehistoric anthropology at the School of Anthropology, Paris; Dr. R. H. Chittenden to be director of the Sheffield Scientific School at Yale University, in succession to Prof. G. H. Brush resigned; Dr. Friedrich Dahl to be assistant in the Zoological Museum, Berlin; Dr. G. P. Eaton to be assistant in osteology in the Peabody Museum; Dr. H. Eggeling to be privat-docent and assistant in anatomy at Strassburg University; Dr. Marcus S. Farr to be curator of the zoological collection of the New York State Museum, Albany; F. G. Hopkins, late demonstrator in physiology at Guy's Hospital, to the new lectureship in chemical physiology at Cambridge University; Dr. Georg Karsten as professor extraordinarius of botany at Kiel University; Gregorius A. Kogevnikov as privat-docent in zoology at Moscow University; Dr. Fr. Kopsch as privat-docent in anatomy at Berlin University; Dr. Kriechbaumer to be curator of the zoological collections at Munich; Dr. W. Kulczycki as privat-docent in zoology at Lemberg University; Dr. Ernst Mehnert of Strassburg to succeed the late Prof. Endres as privat-docent in anatomy at Halle University; Dr. Heinrich Monke of Breslau to the Geological Survey at Berlin; Dr. Lubor Niederle to the newly-founded chair of Slavonic archaeology and ethnology at the Bohemian University, Prague; C. Sauvageau as professor of botany to the Faculty of Sciences, Dijon; Dr. Ernst Vanhoeffen to be assistant in the Zoological Institute at Kiel; Swale Vincent to be Sharpey physiological scholar and chief assistant in the physiological laboratory at University College, London; Dr. Franz Werner, well known for his work on "Coloration and Regeneration in Lizards," as privat-docent in zoology in Vienna University; Dr. A. Zalevski, as privat-docent in botany at Lemberg University.

Professor D'Arcy Thompson, C.B., of University College, Dundee, has been appointed scientific member of the Fishery Board for Scotland, vacant by the resignation of Sir John Murray.

Prof. Ray Lankester has resigned the Linacre Professorship of Comparative Anatomy in the University of Oxford. The past students of Prof. W. F. R. Weldon, of University College, London, are signing a testimonial to their former teacher in view of his candidature for the vacant chair. Among others whose names we have heard mentioned as candidates are Mr. F. E. Beddard, prosector to the Zoological Society of London; Mr. G. C. Bourne, who for many years

has been demonstrator and lecturer at Oxford; and Mr. W. Baldwin Spencer, formerly demonstrator to Prof. Moseley and now professor of zoology at Melbourne. The last mentioned is now visiting "the old country." The field, it will be seen, is a strong one.

Prof. Ch. Dépéret has been elected a member of the Paris Academy of Sciences, in the Section of Mineralogy, in succession to the late N. A. Pomel.

The Special Board for Biology and Geology of Cambridge University, has adjudged the Walsingham Medal for 1898 to J. Graham Kerr, B.A., Fellow of Christ's, for his essay entitled "Notes upon a Research into the Life-History of *Lepidosiren*." Proxime accessit: A. C. Hill, B.A., Trinity, for his essay entitled: "Enzymes and Assimilation."

Dr. O. Seydel, lecturer on Osteology at Amsterdam University, has resigned and returned to Germany.

Pharmaceutical Society of Great Britain.—Isaac Bayley Balfour, M.D., F.R.S., Regius Professor of Botany in the University of Edinburgh; Leonard Dobbin, Ph.D., Lecturer on Chemical Theory in the University of Edinburgh; Alexander Davidson, Montrose; James Laidlaw Ewing, J.P., Edinburgh; James Jack, F.L.S., Arbroath; George Lunan, Edinburgh; Thomas Maben, Hawick; and John Nesbit, Portobello, have been appointed members of the Board of Examiners for Scotland for 1899, under the provisions of the Pharmacy Acts, 1852 and 1868.

As a result of the litigation consequent on the Nobel bequest, a compromise has been effected by which the relatives of the deceased will receive about £211,000, while a sum of nearly £1,400,000 remains for the prizes. The interest on this will make five annual prizes of £8300 each. The subjects of the prizes are given in *Natural Science* for February 1897, vol. x. p. 139.

The subject of the first competition for the Nansen prize is some original research in embryology. The prize, which amounts to about £83, will be awarded at the annual meeting of the Christiania Academy of Science, on May 3, 1900.

The scientific staff proposed for the University of Birmingham, which is intended to absorb and expand the Mason College, includes professors of mathematics, physics, chemistry, metallurgy, zoology, botany, geology and physiography, mining, engineering, anatomy, physiology, bacteriology, and the usual medical subjects. In most cases there is to be a lectureship associated with each professorship. Mr. Chamberlain insisted at the preliminary meeting in November that a provincial University should be in some sense distinctive, "redolent of the soil and inspired by the associations in which it exists," and while recognising the prestige of the medical school and the necessity for giving science a prominent place, maintained that the special feature to be developed should be an organised commercial education. Another of his conclusions will also command sympathy—"that no University will be anything in which the teaching staff is insufficient or is starved."

A hearty response has been given to Lord Kitchener's appeal for £100,000 to found a college at Khartoum as a memorial to General Gordon. But considering the enthusiasm of the public and the amount of idle money in the country, it seems surprising that the money was not at once subscribed many times over. The nobler aspect of the temper of the hour was well expressed in Mr. Rawnsley's "Farewell to Lord Kitchener," in *The Outlook* of Dec. 10.

Under the bequest of the late A. W. G. Allen, the General Board of Studies of Cambridge University proposes to establish a research studentship of the value of £250, tenable for one year, and allotted alternately for scientific and for literary study.

At Cambridge University a John Lucas Walker Studentship in Pathology will shortly fall vacant. Candidates, who may be of either sex, should send in their names by January 19. The studentship is worth £200 per annum for three years.

On November 29th the University of Edinburgh conferred the degree of LL.D. on Lord Kitchener of Khartoum, and the University of Oxford conferred the degree of Master of Arts by diploma upon His Royal Highness Prince Christian Victor of Schleswig-Holstein, G.C.B., Magdalen College, Major in the King's Royal Rifle Corps.

The Maryland Geological Survey, the first Report of which was recently reviewed by us, has, during the past year, considerably enlarged its activities. It systematically collects statistical data concerning the mineral products of the State, which have an annual value of six to seven million dollars. The work of the Survey has been divided as follows:—Geology of the Piedmont Plateau, under the direction of Dr. E. B. Matthews; Geology of the Appalachian Region, under Professor C. S. Prosser; Geology of the Coastal Plain, under Dr. G. B. Shattuck; Highways, under Dr. H. F. Reid; Terrestrial Magnetism, under Dr. L. A. Bauer. Among the assistants are: A. N. Johnson, for highway engineering; Cleveland Abbe, jun., for physiography; B. Sollers and B. W. Barton, for botany. Topographic surveying is carried on in co-operation with the United States Geological Survey, one of whose officers, Mr. H. Gannett, has furnished an elaborate treatise on the aims and methods of topographic work for the report on the cartography of the State. Professor G. P. Merrill of the United States National Museum has reported on the building and decorative stones of Maryland. Extensive areal and economic work has been conducted in the western and central counties. The agricultural conditions, among others, have been considered, and the soils classified in co-operation with Professor Milton Whitney of the United States Department of Agriculture and with the Maryland Experiment Station. The connection of botany with geology is studied in co-operation with the newly organised State Horticultural Bureau.

The State geologist, Professor W. B. Clark, is also Director of the State Weather Service, and proposes to issue a series of reports, in co-operation with many of the United States Government officials. These promise to be of great practical value to the inhabitants of Maryland.

By the connection of the Geological Department of Johns Hopkins University with the Maryland Geological Survey, a great impetus has been given to the study of this science, and the laboratory has been much enlarged. Though Mr. G. K. Gilbert, who used to lecture on physiographic geology, has withdrawn, there are now at least five regular lecturers—namely, Professor W. B. Clark, Drs. Shattuck, H. F. Reid, E. B. Matthews, and Mr. Willis. Lectures have also been delivered during the academic year by Mr. H. M. Wilson, Mr. Fassig, Professor Hans Reusch, and Professor G. P. Merrill. Besides numerous short excursions around Baltimore, a permanent camp was established near Cumberland in the Appalachian Mountains, and, besides the regular instructors, special lecturers from the scientific bureaus in Washington were secured. It is noteworthy that attendance at the meetings of the Geological and Geographic Societies of Washington is considered an important part of the students' work. Members of this very active geological staff also give a course of lectures, with examination papers, to a hundred and ninety-seven teachers of Baltimore.

The multifarious activity, the broad-minded conception of the science, and the intelligent co-operation with all possible sources of help, that mark the geological institutions connected with Johns Hopkins University, reflect the greatest credit on the authorities of the University, especially Professor W. Bullock Clark, and may serve as a lesson to those Universities in this country that seem to have forgotten how essential growth and development are to a continued existence.

The Government of Natal has decided to undertake a complete Geological Survey of the Colony, mainly for the purpose of developing coal and other mineral resources of the country. The services of Mr. W. Anderson have been engaged as Government Geologist to superintend the Survey. Mr. Anderson has for some years been employed on the Indian Geological Survey, and previously served in a similar capacity in New South Wales.

The biological laboratory of the Brooklyn Institute of Arts and Sciences, at Coldspring Harbor, Long Island, has now been established for nine years, and has recently begun a systematic biological survey of the locality. The general outlines of the fauna and flora are sketched by Prof. C. B. Davenport in *Science* for November 18, 1898 (vol. viii. pp. 685-689).

Since her return from Cuba, the U.S. Fish Commission steamer "Fish Hawk" has been working under the command of Lieut.-Commander R. G. Davenport, U.S.N., and the scientific direction of Prof. H. C. Bumpus, in Narragansett Bay and around Block Island. Various problems presented by the marine fauna have been studied, especially those connected with the breeding and distribution of star-fish.

The Swedish Government has approached Her Majesty's Government in connection with a hydrographical conference, for the purpose of considering questions affecting the fishing interest. The Swedish Government is understood to be negotiating also with other powers.

Mr. Alfred L. Jones, says the *British Medical Journal*, has offered £350 a year to found and maintain in Liverpool a laboratory for the study of tropical diseases. This will be associated with the Royal Southern Hospital and University College, Liverpool.

Hyderabad is to have a Pasteur Institute adjoining its hospital and medical school. It is expected to be open for patients before June.

Nature learns from the Trinidad *Bulletin of Miscellaneous Information* that Dr. Morris, whose appointment as superintendent of the Botanical Department for the Lesser Antilles we recently announced, will have the control of the following stations: Barbadoes, Grenada, St. Vincent, St. Lucia, Dominica, Montserrat, Antigua, and St. Kitts. The Jamaica, Demerara, and Trinidad stations will at present remain independent, and a new station, under the control of Trinidad, is to be founded at Tobago.

At a meeting in Edinburgh on November 8th, a committee was appointed to consider the feasibility of establishing a Scottish Zoological Garden. The idea of a "Zoological Society" was mooted, but did not, we are pleased to learn, find support. There are already three or four societies in Edinburgh which have to do with Zoology, and any attempt to insinuate another would simply alienate the sympathies of those who would be glad to see a well-considered Zoological Garden instituted. A committee, including Prof. Cossar Ewart, Dr. Ramsay Traquair, Prof. A. E. Mettam, Mr. Fairgrieve, Mr. W. S. Bruce, Mr. Hope Findlay, and others, was appointed; and we wish them success. We venture to predict that a successful site is to be found in the direction where holidayers do most resort. Proximity to the sea would also be a great advantage. We hope the enthusiasts and the capitalists may come to terms, and that more may soon be heard of this excellent scheme.

The Brighton Aquarium, which has long failed in promoting its original objects, is now in liquidation. We understand that negotiations are in progress for the purchase of the property by a Winter Garden syndicate. At the same time, some energetic citizens of Brighton are promoting a scheme for the establishment of a Zoological Garden on one of the hills behind the town.

In reference to our note last month (xiii. p. 368) on the Frank Buckland collection, we are pleased to learn that a memorial has been prepared for presentation to the Lord President of the Council and the President of the Board of Trade protesting against the removal and distribution of what was brought together after many years of laborious work.

With the view of rescuing the museum from oblivion, and raising it from its present abject position to one of usefulness, it is proposed that it should be made part of the duties of the inspectors of fisheries to preserve and deposit in the Museum of Economic Fish Culture any objects of permanent interest which may come under their notice, together with models of improvements in fish passes, fish-culture apparatus, etc., which may be useful for reference or record. It is also suggested that the secretary and the inspectors of the Fisheries Department, together with the representatives of the Fishmongers' Company, should be appointed visitors to advise on and aid in the efficient management and development of the museum.

The memorial has already been signed by the chairmen of the leading fishery boards throughout the country, and other associations and individuals interested in the fisheries, including the Duke of Richmond, Sir Edward Birkbeck, Sir W. Priestley, Sir Thomas Walpole, Sir George Macpherson-Grant, Lord-Justice A. L. Smith, the prime warden of the Fishmongers' Company, the president of the Fly-Fishers' Club, and representatives of all the leading fishing clubs.

Professor Trail, of Aberdeen University, has set on foot a movement for the formation of a Society and the institution of a Natural History Museum at Aberdeen. The following are amongst the objects of the Society :—(*a*) Collections from the district to illustrate with the utmost possible completeness the local natural history, and history of man from his earliest appearance within the district to the present time. (*b*) Series of types carefully selected to illustrate the leading features of natural history and of man's progress in their wider relationships elsewhere than in the locality; these series to be made of use for teaching. (*c*) Specimens and preparations mounted in boxes, constructed for easy and safe transport; these specimens, etc., to be selected as suitable for instruction in schools, and to be lent to teachers desirous to use them in teaching in their schools, the borrowers defraying carriage both ways, and making good any damage done to objects while in their custody.

Apropos of the Lithographic Exhibition at the South Kensington Museum it is interesting to note that for some time past experiments have been made which seem to show that similar results can be obtained by the use of prepared plates of aluminium. The importance of the discovery will be readily seen when one considers the relative weight and cost of Solenhofen stone and plates of aluminium. It has got to be shown whether the extreme delicacy of the work done of the process of Aloys Senefelder can be produced by the use of the metal.

Mr. John Morgan, of Hastings, who has for many years been engaged in collecting corals, has recently arranged his museum and made it accessible to the public in a suitable building connected with the Hastings Public Baths at White Rock. The hall, we understand, was originally intended for an aquarium, and Mr. Morgan uses some of the tanks for exhibiting various marine organisms. The collection is well labelled, and illustrated both by diagrams and Saville Kent's well-known photographs of the Great Barrier Reef. Mr. Morgan arranges for a weekly lantern lecture or demonstration, and has also secured the services of Mr. Connold, secretary of the Hastings Natural History Society, to conduct visitors round the museum.

In the museum of the Royal Agricultural and Commercial Society of British Guiana, at Demerara, various changes have recently been introduced. The exhibited series of birds has been revised according to the British Museum Catalogue, and over 200 specimens have been remounted by Gerrard and Son of

London. Other groups have been partially revised, so far as is possible in the absence of modern literature. It is hoped that the issue of a revised edition of the British Museum Catalogue of Fishes will enable the curator to work up those animals as completely as the birds; meanwhile a comprehensive collection of British Guiana fishes is being made, and preserved for the most part in formalin. Exhibition space in this museum has been extended by the addition of an upper gallery. Chief among recent acquisitions is a large series of rocks collected in the N.W. District by J. B. Harrison and H. I. Perkins, to illustrate a Government report. The chief difficulty in the curatorial work of this museum is presented by atmospheric changes and over much moisture. It is satisfactory to learn that many inquiries are made at the museum both personally and by correspondence, and that it is becoming more and more a general educating force in the colony.

Mr. Th. Masui reports to Baron van Eetvelde, Secretary of State for the Congo Free State, on the progress of the Congo Museum at Brussels. Over two thousand plants have been collected, of which about five hundred are new to science. Zoological and geological collections are also accumulating, and are being worked up already. Much is expected from the expeditions conducted by Major Cabra in the province of Mayomba, by Lieutenant Lemaire *en route* for Katanga, and by Commander Weyns to the Cataracts and Mid-Congo; and many other enterprises both scientific and practical are contemplated, or have actually begun. The practical side of the museum has two purposes in view—to present a complete collection of the products which the Congo furnishes, and to exhibit the materials which may be advantageously imported there.

Mr. J. G. Robertson has presented to the Edinburgh Museum of Science and Art the unique Skeleton of a Carboniferous Labyrinthodont, *Keraterpeton galvani*, from the Jarrow Colliery, Kilkenny, described and figured by Mr. A. S. Woodward in the *Geological Magazine* for 1897, p. 293.

The *Toynbee Record* for December 1898 gives some account of the excellent work which has been done by Miss Hall, Curator of the Whitechapel Museum, in rendering the collection available for the purposes of elementary education. Parties of school children, under the charge of their teachers, visit the museum, and have demonstration lessons. "Such an elementary museum," Sir William Flower said, "should be in every district in London. It should be the nucleus of the Natural History teaching in the schools, and a stepping-stone to the understanding of our larger museums."

A number of valuable donations have just been made to Dundee Museum by the Egypt Exploration Fund. These consist of an outer and inner mummy case, found in the necropolis of Ha-Khenensu, five tablets from Dendereh, and a large number of interesting archæological objects illustrating the religious and domestic life of ancient Egypt.

Miss Anna T. Jeanes has presented the Philadelphia Academy of Natural Sciences with $20,000, the income to be used for museum purposes.

Four large cases of manufactured Russian antiquities were recently despatched from Warsaw to this country for the benefit of English antiquaries. There is a regular trade in such objects at Kazan. *Verb. sap.*

The scientific societies of Plumstead and Woolwich have formed a committee to urge upon the Library Commissioners the formation of a museum or museums for the locality. The secretary is Mr. T. R. Marr, 6 Russell Place, Woolwich.

In our last number we gave a short account of the proceedings at the International Conference on Scientific Literature convened by the Royal Society. We did not think it necessary to say that we had abstracted this account from our highly valued contemporary *Nature*, since we assumed that

the *procès-verbaux* were public property, and that copies would be distributed to the press, especially the scientific press, in due course. No copy has yet reached us, and we gather from *Science*, as well as from other sources, that no attempt has been made by the Royal Society to furnish the scientific public with any account of the work carried on by this Congress. We now recall the strange fact that the elaborate "Report of the Committee of the Royal Society of London, with Schedules of Classification," though bearing date March 30, 1898, was never heard of by many of those most interested until late on in the year (*vide* articles in *Science*, and by Prof. Victor Carus in *Zoologischer Anzeiger*). It seems to us that the Royal Society does not realise its responsibilities. Why this shrinking from the public gaze? Are the members of the Committees so afraid of criticism? This is a scheme that appeals to the whole world of science; it will have to be supported by money; it will require the ardent co-operation of numerous individuals. To say the very least, it is not wise of the Royal Society to put on its usual airs of superiority and indifference in a matter of this kind. We have excellent reason for believing that the eminent and courteous Secretaries of the Royal Society are not responsible for this darkness where there should be light. Who, then, is the culprit?

In changing their treasurer the Royal Society of London has made an important alteration in its arrangements. From time immemorial the treasurer has been the deputy of the president in the latter's absence, but in the future the deputy of the president will be one of the vice-presidents, as is the custom in the majority of other societies.

The Report of the Council of the Palaeontographical Society adopted at the Annual General Meeting on 17th June, was issued on 21st November, so that the news contained in it is somewhat musty. It is pleasing, however, to learn that the accessions to the ranks of the Society have more than balanced the losses that had arisen from death and resignations; also that £40 : 14 : 0 has been obtained through sale of back stock. Within the next ten years the stock will, it is anticipated, be exhausted. Members can procure at a reduced rate publications more than ten years old; and separate parts, where a sufficient supply exists, can be bought for a sum dependent upon the number of plates. The new members of the council are W. Hill, J. Hopkinson, F. W. Rudler, and D. H. Scott. The president is still Dr. Henry Woodward, and the secretary Rev. T. Wiltshire, 25 Granville Park, Lewisham, London, S.E. The annual subscription is one guinea.

At the meeting of the Geologists' Association, London, on 2nd December, A. M. Davies read "Contributions to the Geology of the Thames Valley." (See p. 14.)

The opening conversazione of the Dublin Naturalists' Field Club was held on October 18; that of the Belfast Club on November 2. At each function Dr. R. F. Scharff and Mr. R. Welch exhibited specimens of *Mysis relicta*, a fresh-water shrimp recently dredged in Lough Neagh. Among the numerous other exhibits, testifying to the activity of both societies, we note *Elatine Hydropiper*, recently discovered in the Lagan Canal, and exhibited by J. H. Davies and W. Gray; new species of foraminifera from the Pleistocene clay of St. Erth, Cornwall, by Joseph Wright; land and fresh-water shells collected in Kerry, and living specimens of the Kerry slug, *Geomalcus maculosus*, by R. Welch.

At the second ordinary meeting of the Scottish Microscopical Society on December 16, a communication was read on "Changes occurring in some cells of the newt's stomach during and after activity," by Dr. E. Wace Carlier, B.Sc.

The officers of the Swedish Geological Society for 1899 are:—President, Prof. A. E. Törnebohm; Secretary, Dr. E. Svedmark; Treasurer, Dr. G. Holm; with G. de Geer and E. Erdmann as Members of Council. At the

meeting on 1st December P. J. Holmqvist read a paper on the Rapakivi Granite of Rödö, near Sundsvall. This district shows numerous variations and interminglings of acidic and basic eruptive rock of post-archaean age . G. Gellerstedt exhibited sections of clay-pits at Ekeby, near Upsala; these were drawn on a natural scale, and showed that the distortions in the clay could not be due to any slipping, but might be ascribed to the pressure of land-ice.

The Society for the Protection of Birds (3 Hanover Square, London, W.), has issued a leaflet, copies of which may be had from Mrs. F. E. Lemon, Hon. Sec., giving a summary of the proceedings at a conference held on Oct. 7, 1898. Mr. John Colan and Mr. W. B. Gerish dealt with imperfections in the Protection Acts; Mr. J. H. Allchin discussed the recent decrease of swallows and martins; Mr. Ernest Bell spoke of the value of birds of prey; and there were other papers.

In future the annual gathering of the learned societies of France is to take place alternately in Paris and the provinces. At Easter next it will be held at Toulouse.

The Economic Society of Mohrungen, near Königsberg, offers a prize of four thousand marks for the best work on the relations of electricity to living organisms.

We regret to see announced in *La feuille des jeunes naturalistes* the dissolution of the Societé des Naturalistes de Provence.

At a meeting of the Royal Physical Society, Edinburgh, on December 21st, the following communications were made:—On results of feeding *Drosera* with various chemical foods, by Miss L. H. Huie; on the age of the Shetland old red sandstone, by Dr. J. S. Flett; exhibition of and remarks on the eggs and embryos of *Ornithorhynchus*, *Echidna*, and *Ceratodus*, by Dr. Gregg Wilson; exhibition of eggs of *Xanthophilus bojeri* from Witu, British East Africa, by J. B. Dobbie.

At the meeting of the Geologists' Association, London, on January 6, Mr. H. W. Monckton will lecture on the glaciers and fjords of the Bergen district, Norway.

On December 15 Mr. J. G. Goodchild gave an address to the Edinburgh Geological Society on some recently exposed rock sections in Edinburgh, and gave approximate estimates of the thickness of the various series:—lower red sandstone, 1000 feet; Craigmillar sandstone, 500 feet; Balagon rocks, 350 feet; volcanic rocks of Arthur Seat, 750 feet; Abbeyhill series, 500 feet; the limestone series, 2000 feet.

On 6th December, Professor G. B. Howes lectured at the Free Public Museum, Whitechapel, on "The Story of a Thigh Bone." Forthcoming lectures are:—10th January, Dr. E. Starling, "How we digest our Dinner"; 7th February, F. A. Bather, "A Piece of Limestone"; 7th March, Miss Cora B. Sanders, "The ways in which Animals warn their Enemies and signal to their Friends"; 11th April, P. Chalmers Mitchell, "Brain." Lecturers at this Museum are sure of a good audience, and the curator, Miss Hall, is always glad to hear of anyone willing to help in this good work.

Several series of Lectures have been delivered during the past autumn at the Manchester Museum. Prof. F. E. Weiss had for his subject "Darwin's Botanical Work on Movement in Plants, Insectivorous Plants, and Fertilisation in Flowers." Prof. S. J. Hickson discussed the "Extinction of Species." Mr. Hoyle begins a Bank Holiday course on "Aquatic Mammals" on Boxing Day, including a special lecture for children, entitled "Water Babies," on January 7th. On January 21st, 28th, and February 4th, Prof. Boyd Dawkins is to lecture on the "Physical Geography of Britain in the Tertiary Period." He is also giving short addresses in the Museum on various Saturday and Sunday afternoons.

On December 3rd Mr. J. Arthur Thomson lectured to the Edinburgh Health Society on "Facts of Inheritance"; on December 11th Dr. Richard J. A. Berry lectured on "The Nervous System, its Uses and Abuses"; and the course closed on December 17th with a lecture by Dr. George R. Wilson on "Rational Enjoyment." The previous lectures in this (the fifteenth) course were on the following subjects: — "Crime," by Lieut.-Col. M'Hardy, Chairman, Prison Commissioners for Scotland; "Corpulence," by Dr. J. C. Dunlop; "Lord Lister and his Work," by Mr. Alexander Miles; "Milk as a Vehicle for the Spread of Disease," by Dr. James Foulis. The last-named has been the subject of a prolonged and animated discussion in the *Scotsman*.

On the 28th November, Mr. C. W. Andrews of the Natural History Department, British Museum, gave a lecture before the Royal Geographical Society on his recent exploration of Christmas Island, the lovely islet which lies in the Indian ocean about 190 miles south of Java. It rises from the summit of a submarine ridge separating two great abysses, the western extremity of the ridge forming the Keeling or Cocos Islands. The climate is delightful, the vegetation luxuriant, the fauna fairly rich, including some new birds and mammals. But it is in its rich deposits of phosphate of lime that the wealth of the island chiefly consists.

The following are among the lecture arrangements at the Royal Institution before Easter:—Sir Robert Ball, 6 lectures (adapted to young people) on Astronomy; Professor E. Ray Lankester, 10, on "The Morphology of the Mollusca"; Mr. A. Henry Savage Landor, 3, on "Tibet and the Tibetans"; Dr. Allan Macfadyen, 4, on "Toxins and Antitoxins"; The Rt. Hon. Lord Rayleigh, 7, on the "Mechanical Properties of Bodies." The Friday evening meetings will begin on January 20, when a discourse will be delivered by Professor Dewar on Liquid Hydrogen.

The year 1899 is the Centenary year of the Royal Institution, and arrangements are being made with a view to its celebration in a fitting manner.

Mr. P. W. Christian, who has spent much time in Samoa and other Pacific islands, and has made a study of Polynesian dialects, lectured at Eton College on October 29. That which most took the fancy of his hearers was his account of how he introduced cricket into several of the islands. The population takes such an interest in the matches that the partisans of the losing side try to loot the houses of the winners. Result, a free fight. Another feature of the game is that every able-bodied man has an innings. Hence a match lasts for many weeks, which, considering its usual termination, may be considered fortunate.

Sven Hedin is classifying his geological specimens, which he will present to the High School of Stockholm, and is preparing a detailed account of his journey from Kathgar to Khotan for *Petermann's Mittheilungen*. His archæological collection and manuscripts will be arranged by Professor Grunwedel, and exhibited in the Berlin Museum, whilst Dr. Ekholm is dealing with the meteorological notes. The maps and charts, covering 552 sheets, have been confided for enlargement and reproduction to Justus Perthes, of Gotha. Dr. Hedin proposes to start on his next journey of Asian exploration about the middle of 1899. He intends to cross the Taklamakan desert twice, thoroughly explore one of the largest rivers of Turkestan, and again study the interesting Lob Nor problem. The most important part of the work will, however, be explorations in the north and interior parts of Tibet. Dr. Hedin hopes to be able to spend a winter in some of the highest alpine regions of Tibet at a height of about 15,000 feet. Then he will pay a visit to the new Viceroy of India, and will return over Himalaya, Karakoram, and Kashgar. Dr. Hedin will again go alone, and he calculates that his three years' travel will cost no more than £2500.

Dr. Chas. F. Millspaugh, of the Field Columbian Museum and of Chicago University, is now undertaking a fourth expedition to Yucatan to study the flora of the interior.

The German Deep-Sea Expedition has already obtained some interesting results. In some of the deep-sea deposits, as well as in samples of water from the greater depths, many forms of bacteria have been observed. By the use of closing nets it has been shown that many crustaceans and fishes, supposed by earlier expeditions to live on the bottom, really belong to the intermediate waters. North of the Canaries the Josephine and Seine Banks rise steeply to within 100 fathoms of the surface. Soundings and temperatures were taken around the Seine Bank, and large numbers of hydroids, antipathids, and the crinoid *Antedon phalangium* were dredged. The last-mentioned was previously well known from the same locality, having been dredged there by the s.s. "Dacia" in 88 fathoms. Continuous observations have been made on temperature, on specific gravity of surface, and when possible of deeper, waters, as well as on density, colour, and transparency of the water, on ocean currents, and on atmospheric changes.

The Prince of Monaco's new yacht, the "Princesse Alice," which left Havre on June 23, made a successful voyage in high northern latitudes and returned to Havre on September 20. Dredgings at great depths were poor, but at lesser depths rich and varied.

Messrs. Chevalier, botanist, and Péjéal, geologist, have accompanied General de Trentinian on an expedition to explore French possessions in the Soudan.

Science informs us that Dr. W. J. M'Gee, of the Bureau of American Ethnology, and Prof. W. H. Holmes of the U.S. National Museum, have returned from explorations in the southern sierra region of California, where important collections were obtained for the museum and observations made on the surviving Indians of the district. Dr. J. Walter Fewkes of the same bureau is now carrying on researches among the Hopi Indians.

News has been received that Dr. H. O. Forbes, of the Liverpool Museum, and Mr. W. R. Ogilvie Grant, of the British Museum, safely landed on the island of Socotra on December 6.

Dr. Donaldson Smith, the American traveller, well known for his journey to Lake Rudolph, and more recent travels in Mongolia, proceeds to Somaliland to collect "big game" and birds for the Gaekwar of Baroda, who is desirous of adding to his already fine Museum of Natural History. He is accompanied in his trip by Mr. Carlile Fraser, of Paisley, who has had long experience of African travel in Nyassaland and Uganda.

In connection with Sir Clement Markham's appeal for subscriptions to a National Antarctic Expedition, there seems some hope of an important nest-egg. When Baron Oscar Dickson made offer of £5000 towards an Antarctic expedition, which was to be under the leadership of the elder Nordenskjold, Sir Thomas Elder offered a similar sum. The project fell through at the time, but it is said that before his death Sir Thomas deposited the above sum in an Adelaide bank, there to wait till the times were ripe.

Mr. F. H. Knowlton, of the U.S. National Museum, communicates the following note to *The Plant World* for November 1898 :—"While collecting fossil plants in the State of Washington during the past season I discovered, about one mile north of the town of Liberty, a deposit nearly a foot in thickness made up almost entirely of gigantic palm-leaves. They are of the ordinary palmate or palm-leaf fan shape, with a petiole nearly an inch in diameter, and although no absolutely perfect specimen could be obtained, from the leaves being so matted together, there is evidence that the leaves must have been from four to six feet in diameter. It represents an undescribed species of *Sabal*."

The Council of the Marine Biological Association reports that the equipment of the laboratory and boats is now sufficiently complete to allow of a very much larger amount of scientific work being done, if the services of more naturalists could be retained for lengthened periods; but such development demands increased income. Twenty-one naturalists carried on research work at the laboratory during the year 1897-98. From the Director's report we gather that an Anglo-French Committee has been formed to investigate the physical and biological conditions of the English Channel during 1899, that £100 has been granted towards this by the British Association, and that Mr. H. N. Dickson will help in the physical part of the work. Dr. Allen gives a list of twenty naturalists who have worked at the laboratory; eight of these are not mentioned in the Council's report, owing, we suppose, to the difference of date. More attractions have been introduced in the aquarium, and an iron shed for storage has been added at the back of the laboratory.

On 10th December, Sir John Gorst addressed a large meeting of agriculturists at Cambridge, on the necessity of reform in the educational system of our agricultural districts. He referred to the evidence gathered by the Dublin Recess Committee as to what was being done in France, Belgium, Holland, Switzerland, and Denmark. The reports of the Commissioners showed that the chief reason of the agricultural prosperity of those countries, which so successfully competed with Great Britain, was the education of all classes, both adults and children, in the technical knowledge appertaining to their industry. He then sketched a system to effect the necessary reforms essential to the establishing of sound agricultural education in this country.

Attempts have been made more than once to utilise the thread of the spider in the same way as that of the silkworm, and about a century ago stockings were woven from it. The latest application is to balloon ropes for use by the military aeronauts of France, and a factory is in successful operation at Chalais-Meudon, near Paris. According to the *Board of Trade Journal*, the spiders are arranged by dozens above a reel, upon which the threads are wound. Each spider has to furnish 30 to 40 yards. The reddish and sticky outer cover is washed from the threads, which are then twisted by eights into yarn. This is both stronger and lighter than silk cords of the same thickness; but it is also much more expensive. The chief difficulty in these experiments has always been the feeding of the spiders.

The Government of New Zealand has issued an order protecting the eggs as well as the young of the interesting Tuatara lizard.

Caen Museum thought it was going to buy a fine meteorite weighing 750 kilos, and said to have fallen at Vierville (Manche) in April 1897. Alas! the meteorite never fell. It was the brilliant invention of a newspaper man.

The *Feuille des Jeunes Naturalistes* (35 Rue Pierre-Charron, Paris) proposes (from November 1, 1898) to lend the books of its scientific library to those subscribers who live in neighbouring countries.

A catalogue of these works is being issued, and up to this date twenty-four parts, comprising 33,000 numbers, have been published.

It is intended to add to the General Catalogue special catalogues on definite branches of Natural History, completing these by the acquisition of the various works issued on the subject. That on Collembola and Thysanura (anatomy, biology, systematic) was published on November 30. Those on the Tertiaries of Europe (1st part) and Cecidiology (study of galls from a botanical and an entomological standpoint) will be issued shortly. Other subjects are being worked out. The annual subscription to the Library, including the Magazine and the Library Catalogues, has been fixed at 16s. for English subscribers. Pamphlets can be borrowed for their postage (English stamps taken), and kept

for two months. The idea is novel, and should prove useful to those not connected with any large library. We hope that our colleague, Mr Adrien Dollfus, will meet with success.

The use of the globes, at one time a polite accomplishment, has of late been set aside in consequence of the great improvement in cartography and increased cheapness of maps. But the last year has witnessed a return to favour of the more natural method of representation, and interest in globes has been stimulated by the gigantesque proposals of Elisée Reclus. It is therefore an opportune announcement of Dietrich Reimer, Berlin, that he has now on sale a geologically coloured globe of the Earth, prepared by M. Pütz under the direction of Professor W. Dames. This shows not only the solid geology of the land, but also the deposits now forming in the seas, such as red clay and *Globigerina* ooze; this part of the work is based on the maps of Murray and Renard in the "Challenger" Reports. The diameter of the globe is 34 centimetres (21¼ inches). The price is 25, 32, or 40 marks, according to the method of mounting.

The Government of British Guiana recently attempted to introduce the Indian buffalo (*Bos bubalus*) into that colony, but the experiment is likely to be a failure, since the animals cannot get enough water wherein to cool themselves at some seasons. Buffaloes from Indo-China have thrived and bred in Surinam for about four years, while in Cayenne they have done equally well for over ten years.

The friends of the late well-known Warwickshire geologist, the Rev. P. B. Brodie, have decided to place a window to his memory in Rowington Church, of which he was Vicar for forty-five years. The Hon. Secretary to the fund is Mr. J. Booth, Rowington Hall, Warwick.

In reference to a remark which we made (*Nat. Sci.* xiii. p. 435), Mr. George Abbott, Hon. Sec. of the S.E. Union of Scientific Societies, has informed us that the institution of a Postal Magazine Club has been attended by an *increase* in the number of periodicals bought by the members, and not by a decrease. This, from our point of view, is indeed a consummation devoutly to be wished.

The London School Board has taken a practical step to further the study of botany. Arrangements have now been made, which will come into operation in April next, whereby a gardener will forward to the schools botanical specimens required for teaching botany or for object lessons, or for the combination of drawing and object lessons.

The total output of gold ore in the United Kingdom in 1897 was, according to Dr. Le Neve Foster, 4517 tons, the total value at the mines being £6282. Copper mining is a decaying industry. The output of lead ore is also declining; last year it was only 35,338 tons, the smallest recorded during the last half century. The output of zinc ore, 19,278 tons, does not reach the average of the last quarter of a century. On the other hand, the output of coal last year was 202,129,931 tons, the highest hitherto recorded, while the output of iron ore reached 13¾ million tons.

The Entomologist of the United States Department of Agriculture has issued an appeal for separate authors' copies of papers on insects, so that these may be filed under their appropriate heads in the Library of his division. The publications of the division are very liberally distributed, but authors' copies are usually sent to individuals, and so become private property. Any that are sent in response to this very justifiable request should be marked "For the Library of the Division of Entomology." The valuable publications of this department, to which we so often refer, will prove a rich return to the senders.